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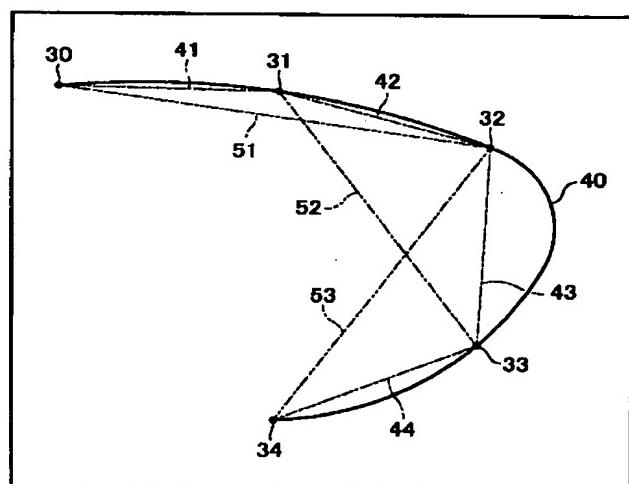
(54)【発明の名称】 曲線識別システム

(57)【要約】

【課題】 情報処理能力に制約の有る曲線識別システムにおいて、曲線の画像情報を局所的かつ断片的に認識処理し、当該曲線が回転及び移動した場合にも、特定可能であり、ノイズにも強い曲線識別システムが望まれていた。

【解決手段】 曲線画像の中で重要性の高い要素、例えば曲線形状、傾き及び位置等を全て簡素な数値により表現し、その数値データの保存及び照合を簡素な装置で高速かつ正確に行う。前記曲線形状は当該曲線上に等間隔弦を沿わせたサンプリング点を適宜結んだ複数の弦の長さで、前記傾き及び位置等は座標により数値化することのできるアルゴリズムを備えた。

特徴弦の数値化



## 【特許請求の範囲】

【請求項1】 曲線を表すデータ形式として、特異点(30)に始まる曲線(40)の延長方向を単位長さの弦(41)(42)(43)(44)でたどって順次1単位長さづつ測定点(31)(32)(33)(34)を付しながら前記曲線(40)の末端まで進行し、前記特異点(30)及び前記各測定点から2単位先の測定点までの弦(51)(52)(53)の長さを順次計測する計測手段と、その計測データの数値群によって曲線形状の記憶、再生、又は照合をすることを特徴とする曲線識別システム。

【請求項2】 巨視的には緻密であり微視的には所定の間隔を持って規則的に配列された複数の画素からなる画像を前記数値群に変換する画像処理アルゴリズムにおいて、測定点(12)が前記間隔の位置に存在する場合に、前記曲線上のある基準点(100)から規定の直線距離(99)にある前記曲線上の測定点(12)の座標を算出する手段として、前記基準点(100)から規定の直線距離(99)より近くにある第一の画素位置(10)と前記基準点(100)から規定の直線距離(99)より遠くにある第二の画素位置(11)と前記基準点(100)とを結ぶ三角形を想定し、前記基準点(100)と第一の画素位置(10)を結ぶ第一辺と、前記基準点(100)と第二の画素位置(11)を結ぶ第二辺の長さ及び前記規定の直線距離(99)との比率により、第一の画素位置(10)と第二の画素位置(11)を結ぶ第三辺を比例配分することによって前記測定点(12)の座標を特定すべく近似計算する測定点算出アルゴリズムを備えたことを特徴とする請求項1に記載の曲線識別システム。

【請求項3】 曲線(400)を表すデータ形式として、前記曲線(400)の弦(501)(502)(503)(504)の中の二つの弦がなす角度などの曲線の湾曲の方向を示す方位角(408)又は曲率度(409)(410)(411)と弦(501)(502)(503)(504)の長さを組み合わせた前記数値群によって前記曲線(400)の形状及び方向まで特定して記憶、再生、又は照合をすることを特徴とする請求項1又は請求項2に記載の曲線識別システム。

【請求項4】 曲線(400)を表すデータ形式として、特定の弦(501)のどちらか片端にある特定の軌跡点(402)(403)(404)(405)の位置を位置データに数値化する位置測定手段と、その位置データを含めた前記数値群によって前記曲線(400)の形状、方向及び位置まで特定して記憶、再生、又は照合をすることを特徴とする請求項3に記載の曲線識別システム。

【請求項5】 複数に分割されたブロック画像に細分化するブロック細分化手段と、該ブロック画像のコントラストを強めて白黒に二値化して二値化処理画像を得る第

1の二値化処理手段と、該二値化処理画像から前記指紋の凸条模様即ち隆線の方向を検出する隆線方向検出手段と、前記隆線の方向に沿った線の画像情報を有効と判断し、前記隆線の方向に沿わない画像情報をノイズと判断して、そのノイズを除去して改善画像を得るグレースケール画像改善手段と、該改善画像のコントラストを強めて白黒に二値化し二値化処理画像を得る第2の二値化処理手段と、複数の画素幅からなる前記隆線をその画素幅の中心に向かって幅圧縮することにより单一の画素幅にまで細線化した隆線に変換する細線化手段と、同方向の隆線を持つ近接する端点(20)若しくは分岐点に近接する端点(21)、又は画像の枠に近接する端点(22)を、ノイズで前記隆線が欠落して発生した疑似特異点と見なして連結する疑似特異点補正手段と、該疑似特異点補正を施した後の前記隆線の端点及び分岐点を真の特異点と見なして抽出する特異点抽出手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項4の何れか1項に記載の曲線識別システム。

【請求項6】 ある特徴点(91)に対応づけられた他の隆線上的点を二次特徴点(92)(93)(94)(95)とし、その二次特徴点(92)(93)(94)(95)を始点とする隆線の形状(RS1)(RS2)(RS3)(RS4)を特異点隆線形状として指紋の特徴点に付加する特異点抽出手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項4の何れか1項に記載の曲線識別システム。

【請求項7】 前記細線化手段と、前記疑似特異点補正手段により縦列接続処理部となし、その縦列接続処理部に原白黒画像を通過させて第1の分類の前記端点のみを抽出する第1回目の端点抽出処理と、その第1の端点抽出処理により抽出した信号を白黒反転させるポジネガ反転手段と、その白黒反転した信号が第2回目に前記縦列接続処理部を通過して得られる第2の分類の前記端点を抽出する第2の端点抽出処理をなすことにより、前記原白黒画像の隆線における端点と分岐点の両方を得られる特異点抽出手段となし、指紋照合に応用したことを特徴とする請求項5に記載の曲線識別システム。

【請求項8】 指紋の疑似特徴点と真の特徴点を識別する手段として、隆線又は谷線の分岐点(101)に接続する三つのそれぞれの隆線又は谷線について、前記分岐点(101)から等距離に離れた隆線上又は谷線上の点(102)(103)を求め、前記分岐点(101)を原点と見なした時の三つの点(102)(103)(104)の二次元座標(Xa, Ya), (Xb, Yb), (Xc, Yc)を求め、これら三点(102)(103)(104)のうちのいずれかの二点(102)(103)において、二点の座標(Xa, Ya), (Xb, Yb)の水平成分の積(Xa・Xb)と垂直成分の積(Ya・Yb)を足した値(Xa・Xb + Ya・Yb)がある閾値よりも大きい場合、これを真の分岐点であると見なし、閾値よりも大きな値をとるような二点が存在し

ない場合は疑似分岐点であると見なすことにより、非常に少ない計算量で前記識別する目的を実現可能にする疑似分岐点判別手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項4の何れか1項に記載の曲線識別システム。

【請求項9】 ラスタースキャン方式で入力する指紋画像を撮影するテレビカメラ若しくは同等の指紋画像入力手段と、それらの指紋画像入力手段により、入力された指紋画像を、1フレームにおいて局所的かつ断片的に前記ブロック画像を読み取る直後に、前記数値群にまで逐一処理する信号処理手段と、複数のフレームでの指紋画像の異なるブロック画像の処理を繰り返して指紋画像全体の数値化処理を行う手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項7の何れか1項に記載の曲線識別システム。

【請求項10】 二つの指紋が同一のものか否かを判別する指紋照合手段において、樹目状に分割された二次元空間に、それぞれの樹目がメモリ番地に対応した書き込み読み出し可能メモリを用意し、二つのそれぞれの指紋から抽出された特徴点を一つずつ任意に選び、これら二つの特徴点の形状の類似度が高い場合には大きい値を出し、類似度が低い場合には小さい値を出す類似度指標値を計算する手段と、この類似度指標値を二つの特徴点を結ぶ二次元ベクトルの水平成分および垂直成分の値を二次元座標とする前記説明の樹目に応するメモリ番地に格納されている値に足した累積値を再び同じメモリ番地に書き込む一連の操作を繰り返し、最終的にメモリ上に格納されているデータ値のうち最大のものをこれら二つの指紋の総合的な類似度指標値とし、この総合的な類似度指標値がある閾値以上の場合は同一の指紋であると判定し、閾値より小さければ異なる指紋であると判定し、指紋の平行移動に関する位置のずれ補正を必要としないことを指紋照合に応用したことを特徴とする曲線識別システム。

【請求項11】 平行移動に関する位置ずれ補正を必要としない指紋照合手段を具備した請求項10に記載の曲線識別システムにおいて、回転に関する位置ずれの補正について、比較する二つの指紋のうちの一方に含まれるすべての特徴点の座標を基準原点を中心に回転補正し、それらの特徴点形状については、その特徴点の方位角を同じ角度で回転補正し、任意の回転および平行移動のずれにも高精度な照合を可能にしたことを特徴とする曲線識別システム。

【請求項12】 1つの指紋画像を6乃至7フレーム分の所要時間25分の6秒以内で読み取りかつ数値化処理まで完了するアルゴリズムを備えて指紋照合に応用したことを特徴とする請求項9に記載の曲線識別システム。

【請求項13】 前記特異点につながる前記隆線の形状を前記数値群により特定した指紋特徴データとし、その指紋特徴データに対する照合用として予め登録された照

合見本若しくは構築されたデータベースに照合する照合手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項12の何れか1項に記載の曲線識別システム。

【請求項14】 前記細分化、前記ノイズに対する改善又は補正処理、前記二値化、前記細線化、前記指紋特徴データの収集及び照合の一連のデータ処理を毎秒1億命令実行可能なコンピュータが動作し、1つの指紋画像あたりに必要最小限40乃至60バイトの前記指紋特徴データを割り当てた前記照合手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項13の何れか1項に記載の曲線識別システム。

【請求項15】 端末器から入力された前記指紋画像から必要最小限40乃至60バイトの前記指紋特徴データを抽出する抽出手段と、該指紋特徴データを通信ネットワークに接続して前記データベースに照合した結果を前記端末器に通知する手段を備え、指紋照合に応用したことを特徴とする請求項1乃至請求項14の何れか1項に記載の曲線識別システム。

【請求項16】 医療又は社会福祉又はサービス業又は行政又は金融機関の本人履歴データ検索、施錠、各種発券、出札、改札、検札、検問、課金、電子商取引、資産管理運用のうちの何れかの機能を有する端末器又は単独の装置に組み合わせて配設し、指紋照合を本人確認手段として使用することを特徴とする請求項1乃至請求項15の何れか1項に記載の曲線識別システム。

【請求項17】 ソフトウェアの秘密保護、又は製造委託LSIの設計データ秘密保護の機能の一部として、秘密保護の対象品自体に埋め込む構造により配設し、指紋照合を本人確認手段として使用することを特徴とする請求項1乃至請求項16の何れか1項に記載の曲線識別システム。

【請求項18】 複数の指の指紋特徴データから論理演算により本人確認の規則を設定することを特徴とする請求項1乃至請求項17の何れか1項に記載の曲線識別システム。

#### 【発明の詳細な説明】

##### 【0001】

【発明の属する技術分野】 本発明は、犯罪捜査から鍵やカードに代わる施錠装置、切符や定期券に代わる検札、クレジットカードや暗唱番号及び印鑑に代わるキャッシュレス信用取引、電話の声で本人を確認していた株式売買等の資産管理運用にも代わる電子商取引、医療カルテ又は社会福祉又はサービス業又は行政その他の履歴データ例えば戸籍謄本の検索、バッジ及び顔を目視することによる識別に頼っていた専任の守衛業務にまで応用できる本人確認手段としての指紋照合システムに応用できる曲線識別システムに関する。

##### 【0002】

【従来の技術】 従来の指紋照合システム等で応用されて

いた曲線識別システムでは指紋全体の画像に対して、特徴の現れやすいか否かの場所の区別や、画像内容に応じて情報価値に重み付けすることもなく、指紋画像の全体を均一に、あたかも肉眼で照合するようにデータベース及び照合システムを構成していた。

#### 【0003】

【発明が解決しようとする課題】しかし、指紋等の曲線には回転、移動及びノイズに擾乱されにくい局所的な特異点及び隆線形状でなる特定項目すなわち情報価値の高い部分の画像とそうでない部分の画像があり、照合の際にそれらを有効に利用する必要があり単純に一律に取り扱う方法も無駄が多かった。そして、照合システムの基礎となるデータベースを構成するためのデータ格納部においては、情報価値の少ない部分の画像データまでも一律に保存してしまえば、メモリ容量を無駄遣いするので照合システムのコストアップ及び照合の速度制限の要因になっていた。

【0004】又、照合する際にも要点のみに絞られていない未加工データのままに的を得ない照合作業を無駄に進行させていたのでは、照合作業の効率も悪く、高い照合率を得ることは困難であった。さらに、指紋照合の場合には隆線形状の画像データを、特異点の位置及び特異点に直接関係させずに照合作業に用いると、本来ならば照合作業に寄与するはずの特異点との関係を示す情報が利用されず、そのために回転、移動及びノイズによる照合劣化が顕著であった。

【0005】本発明はかかる従来の指紋照合等に用いられていた曲線識別システムの欠点を除去し、メモリ容量を無駄遣いせず、照合する際にも要点のみに絞って効率良く、さらに隆線形状の画像データに関しては、特異点との位置関係を示す数値情報のみでなる特徴データを有効利用し、回転、移動及びノイズによる照合精度の劣化を避け、照合過程を高速かつ正確に進行させることにより高い照合率で迅速な結果が得られ、指紋照合等に応用できる曲線識別システムを安価に提供することを目的としている。

#### 【0006】

【課題を解決するための手段】前記目的を達成するために、請求項1に係る発明は、曲線を表すデータ形式として、特異点(30)に始まる曲線(40)の延長方向を単位長さの弦(41)(42)(43)(44)でたどって順次1単位長さづつ測定点(31)(32)(33)(34)を付しながら前記曲線(40)の末端まで進行し、前記特異点(30)及び前記各測定点から2単位先の測定点までの弦(51)(52)(53)の長さを順次計測する計測手段と、その計測データの数値群によって曲線形状の記憶、再生、又は照合をするようにした。

【0007】このようにしたことにより、湾曲の方向が反転しない曲線であれば、3つの弦(51)(52)

(53)の長さと前記単位長さの数値情報のみから、1つの特異点(30)及び4つの測定点(31)(32)(33)(34)の位置関係を復元できる。そして、重複する測定点を考慮しながら、この操作を繰り返すことにより、湾曲の方向が反転しない曲線であれば、完全に元の曲線を復元又は特定できる。しかも、このような曲線形状の表し方は、同じ曲線を移動又は回転させても、3つの弦(51)

(52)(53)の長さ、1つの特異点(30)及び4つの測定点(31)(32)(33)(34)の位置関係は不变である。

【0008】そして、この方法ならば、少ないメモリ容量で曲線を表すことができる。従って、湾曲の方向が反転しない曲線であれば、曲線の長さと形状を計測データの数値群のみによって正確に記憶、再生、又は照合することができる。しかも、試料を移動又は回転させても支障なく曲線の識別ができる。即ち、この曲線を表すデータ形式は、移動や回転に強い曲線形状の表し方である。

【0009】一般に、数値群のみの比較であれば、人よりも機械の方が断然有利である。これらのこととは、人にはできても機械には比較的困難とされていた、「ものの形状パターン認識」を略完全に機械に置き換えて、なお余りあるほどの膨大なデータベースを高速かつ正確に処理できる効果をもたらす。

【0010】又、請求項2に係る発明は、巨視的には緻密であり微視的には所定の間隔を持って規則的に配列された複数の画素からなる画像を前記数値群に変換する画像処理アルゴリズムにおいて、前記測定点が前記間隔の位置に存在する場合に、前記曲線上のある基準点(100)から規定の直線距離(99)にある前記曲線上の測定点(12)の座標を算出する手段として、前記基準点(100)から規定の直線距離(99)より近くにある第一の画素位置(10)と前記基準点(100)から規定の直線距離(99)より遠くにある第二の画素位置

(11)と前記基準点(100)とを結ぶ三角形を想定し、前記基準点(100)と第一の画素位置(10)と結ぶ第一辺と、前記基準点(100)と第二の画素位置(11)を結ぶ第二辺の長さ及び前記規定の直線距離

(99)との比率により、第一の画素位置(10)と第二の画素位置(11)を結ぶ第三辺を比例配分することによって前記座標を特定すべく近似計算する測定点算出アルゴリズムを備えた。

【0011】このことにより、有限の分解能でしかありえない撮像面等、即ち拡大して見れば隙間だらけに配列された視覚機能を有する複数の画素の隙間部分に存在して見落とされる点をも、計算上は厳密に推定できるので、理論的には無限の分解能を追求できる。

【0012】又、請求項3に係る発明は、曲線(40)を表すデータ形式として、前記曲線(400)の弦(501)(502)(503)(504)の中の二つの弦がな

す角度などの曲線の湾曲の方向を示す方位角(408)又は曲率度(409)(410)(411)と弦(501)(502)(503)(504)の長さを組み合わせた前記数値群によって前記曲線(400)の形状及び方向まで特定して記憶、再生、又は照合をするようにした。

【0013】このようにしたことにより、S字状に湾曲の方向が反転する曲線であっても、その曲線の湾曲方向まで特定しながら形状を識別し、数値から曲線への再現も完全に可能となり、さらに認識画面上で回転した曲線をも、方向を示す数値以外の数値が一致していれば、似た形状の曲線でありながらも、それらの違いを、識別することが可能となる。逆説的には、単に回転したに過ぎないであろう一見して類似形状の曲線を照合すれば、同一の曲線形状であることを断定できる。

【0014】又、請求項4に係る発明は、曲線(400)を表すデータ形式として、特定の弦(501)のどちらか片端にある特定の軌跡点(402)(403)

(404)(405)の位置を位置データに数値化する位置測定手段と、その位置データを含めた前記数値群によって前記曲線(400)の形状、方向及び位置まで特定して記憶、再生、又は照合をする。このようにしたことにより、認識画面上で曲線が移動した位置を示す数値の違いによってそのことを識別することが可能となる。逆説的には、単に移動したに過ぎないであろう一見して類似形状の曲線を照合すれば、同一の曲線形状であることを断定できる。

【0015】又、請求項5に係る発明は、複数に分割されたブロック画像に細分化するブロック細分化手段と、該ブロック画像のコントラストを強めて白黒に二値化して二値化処理画像を得る第1の二値化処理手段と、該二値化処理画像から前記指紋の凸条模様即ち隆線の方向を検出する隆線方向検出手段と、前記隆線の方向に沿った線の画像情報を有効と判断し、前記隆線の方向に沿わない画像情報をノイズと判断し、そのノイズを除去して改善画像を得るグレースケール画像改善手段と、該改善画像のコントラストを強めて白黒に二値化し二値化処理画像を得る第2の二値化処理手段と、複数の画素幅からなる前記隆線をその画素幅の中心に向かって幅圧縮することにより单一の画素幅にまで細線化した隆線に変換する細線化手段と、同方向の隆線を持つ近接する端点(20)若しくは分岐点に近接する端点(21)、又は画像の枠に近接する端点(22)を、ノイズで前記隆線が欠落して発生した疑似特異点と見なして連結する疑似特異点補正手段と、該疑似特異点補正を施した後の前記隆線の端点及び分岐点を真の特異点と見なして抽出する特異点抽出手段を備え、指紋照合に応用した。このようにしたことにより、ノイズを含む指紋の入力画像に対しても、高い照合率で指紋照合ができる。

【0016】又、請求項6に係る発明は、個人の指紋の中には隆線の端点や分岐点といった特異点が非常に少な

いものがあり、真の特異点のみを用いた指紋照合手段では適用範囲に限界があったところを、前記真の特異点に基づいて、新たに抽出した特異点を始点とする隆線形状を指紋の特徴点とする手段である。そこで、ある特徴点(91)に対応づけられた他の隆線上の点を二次特徴点(93)(94)(95)とし、その二次特徴点(93)(94)(95)を始点とする隆線の形状(RS2)(RS3)(RS4)を特異点隆線形状として指紋の特徴点に付加する特異点抽出手段を備え、指紋照合に応用した。したがって、始点を真の特異点から特定できる二次的な特異点を設定して、その点を始点とする隆線形状を指紋情報に付加することによって、適用範囲を大幅に拡大することを可能にしている。具体的には、特異点隆線形状だけでは登録できなかった指紋も、ほぼ100%登録し、照合できるようになった。

【0017】又、請求項7に係る発明は、前記細線化手段と、前記疑似特異点補正手段により縦列接続処理部となし、その縦列接続処理部に原白黒画像を通過させて第1の分類の前記端点のみを抽出する第1回目の端点抽出処理と、その第1の端点抽出処理により抽出した信号を白黒反転させるポジネガ反転手段と、その白黒反転した信号が第2回目に前記縦列接続処理部を通過して得られる第2の分類の前記端点を抽出する第2の端点抽出処理をなすことにより、前記原白黒画像の隆線における端点と分岐点の両方を得られる特異点抽出手段となし、指紋照合に応用した。

【0018】このようにしたことにより、二股に分岐する前記隆線を白黒反転処理に伴って、画像構成を究極まで簡素化し、分岐も交差もしない単純曲線の集合だけである画像構成とし、その簡素化された画像構成で指紋照合するので、膨大な試料数の機械照合に最適となり、従来よりも少ないメモリ量を初めとする簡素な設備により、高速かつ正確な指紋照合が可能となる。

【0019】又、請求項8に係る発明は、指紋を捉えた画像では、様々な要因で発生するノイズによって、隆線又は谷線が分断され、疑似特徴点が発生することが多く、この疑似特徴点を真の特徴点から識別する効率的な手段を提供することを目的とする。

【0020】そこで、指紋の疑似特徴点と真の特徴点を識別する手段として、隆線又は谷線の分岐点(101)に接続する三つのそれぞれの隆線又は谷線について、前記分岐点(101)から等距離に離れた隆線上又は谷線上の点(102)(103)を求め、前記分岐点(101)を原点と見なした時の三つの点(102)(103)(104)の二次元座標(Xa, Ya), (Xb, Yb), (Xc, Yc)を求め、これら三点(102)(103)(104)のうちのいずれかの二点(102)(103)において、二点の座標(Xa, Ya), (Xb, Yb)の水平成分の積(Xa・Xb)と垂直成分の積(Ya・Yb)を足した値(Xa・Xb + Ya・Yb)がある閾値よりも大きい場合、これを真の分岐

点であると見なし、閾値よりも大きな値をとるような二点が存在しない場合は疑似分岐点であると見なすことにより、非常に少ない計算量で前記識別する目的を実現可能にする疑似分岐点判別手段を備え、指紋照合に応用した。このようにしたことにより、ノイズによって発生する疑似特徴点を少ない計算量と高い精度で真の特異点から区別することが可能になった。

【0021】又、請求項9に係る発明は、ラスタースキャン方式で入力する指紋画像を撮影するテレビカメラ若しくは同等の指紋画像入力手段と、それらの指紋画像入力手段により、入力された指紋画像を、1フレームにおいて局所的かつ断片的に前記ブロック画像を読み取る直後に、前記数値群にまで逐一処理する信号処理手段と、複数のフレームでの指紋画像の異なるブロック画像の処理を繰り返して指紋画像全体の数値化処理を行う手段を備え、指紋照合に応用した。

【0022】このようにしたことにより、メモリ容量を浪費していた指紋画像全体の生画像データ、即ち情報量削減処理のなされる以前の画像情報をためること無く、少ないメモリ容量でシステム構成できる。

【0023】要するに一枚の指紋画像の情報量は多すぎて、メモリ容量を浪費するので、指紋照合の目的に沿って、画像構成を究極まで簡素化し、数値化する処理を、指紋のブロック画像の各ブロック部分ごとに逐一に実行すれば、無駄な情報を蓄えるメモリ容量も不要である。

【0024】そして、前記逐一処理に要する時間分だけ、前記ラスタースキャンが進行しても、処理している間は指紋画像を読み飛ばせば済む。そして、指紋照合に必要なブロック画像のブロック部分は次のフレームでのラスタースキャンの機会を待って読み取ることにより、指紋の全体像が得られる。

【0025】尚、本システムにおいては、必ずしも指紋の全体像が得られなくとも、指紋照合できる。又、それだからこそ、前記局所的かつ断片的に前記ブロック画像を読み取るこの方式が有効なのである。

【0026】又、請求項10に係る発明は、二つの指紋が同一のものか否かを判別する指紋照合手段において、それぞれの指紋の各特徴点の類似度指標値を計算して総合的な指紋の類似度指標を得る手段があり、指紋の回転をも伴う位置ずれを補正するために膨大な計算量が必要とされていたが、その計算量を軽減させることを目的としている。すなわち、この位置ずれの補正のうち、平行移動のずれ補正の必要性を排除し、極めて高速な指紋照合を実現可能とする手段を提供することを目的である。

【0027】そこで、二つの指紋が同一のものか否かを判別する指紋照合手段において、枠目状に分割された二次元空間に、それぞれの枠目がメモリ番地に対応した書き込み読み出し可能メモリを用意し、二つのそれぞれの指紋から抽出された特徴点を一つずつ任意に選び、これら二つの特徴点の形状の類似度が高い場合には大きい値

を出し、類似度が低い場合には小さい値を出す類似度指標値を計算する手段と、この類似度指標値を二つの特徴点を結ぶ二次元ベクトルの水平成分および垂直成分の値を二次元座標とする前記説明の枠目に対応するメモリ番地に格納されている値に足した累積値を再び同じメモリ番地に書き込む一連の操作を繰り返し、最終的にメモリ上に格納されているデータ値のうち最大のものをこれら二つの指紋の総合的な類似度指標値とし、この総合的な類似度指標値がある閾値以上の場合は同一の指紋であると判定し、閾値より小さければ異なる指紋であると判定し、指紋の平行移動に関する位置のずれ補正を必要としないことを指紋照合に応用した。

【0028】又、請求項11に係る発明は、請求項10と同様の目的であり、前記位置ずれの補正のうち、回転のずれ補正の必要性を排除し、極めて高速な指紋照合を実現可能とする手段を提供することを目的とする。

【0029】そこで、平行移動に関する位置ずれ補正を必要としない指紋照合手段を具備した請求項10に記載の曲線識別システムにおいて、回転に関する位置ずれの補正について、比較する二つの指紋のうちの一方に含まれるすべての特徴点の座標を基準原点を中心に回転補正し、それらの特徴点形状については、その特徴点の方位角を同じ角度で回転補正し、任意の回転および平行移動のずれにも高精度な照合を可能にした

【0030】又、請求項12に係る発明は、1つの指紋画像を6乃至7フレーム分の所要時間25分の6秒内で読み取りかつ数値化処理まで完了するアルゴリズムを備えて指紋照合に応用した。このようにしたことにより、実用性を維持しながら設備の簡素化を実現できた。

【0031】何故ならば、例えば毎秒25フレーム又は30フレームを継続して撮像するテレビ撮影のうちの6フレームで指紋の全体像が得られるとすれば、1つの指紋画像を25分の6秒又は30分の6秒の所要時間で読み取りかつ数値化処理まで完了する。このことは、意外に情報量の多いデジタルカメラ等の写真撮影データで指紋画像を一枚分保持して処理するよりも、システム全体の簡素化及びコストダウンを図ることを意味する。

【0032】又、請求項13に係る発明は、前記特異点につながる前記隆線の形状を前記数値群により特定した指紋特徴データとし、その指紋特徴データに対する照合用として予め登録された照合見本若しくは構築されたデータベースに照合する照合手段を備え、指紋照合に応用したので、少ないメモリ容量で照合速度及び照合率を高めることができ、実用レベルとしては従来のものよりも格段に高速かつ正確な照合ができる。

【0033】又、請求項14に係る発明は、前記細分化、前記ノイズに対する改善又は補正処理、前記二值化、前記細線化、前記指紋特徴データの収集及び照合の一連のデータ処理を毎秒1億命令実行可能なコンピュータが動作し、1つの指紋画像あたりに必要最小限40乃

至60バイトの前記指紋特徴データを割り当てた前記照合手段を備え、指紋照合に応用したので、さらに大幅なメモリ領域の削減と高速での照合ができる。

【0034】又、請求項15に係る発明は、端末器から入力された前記指紋画像から必要最小限40乃至60バイトの前記指紋特徴データを抽出する抽出手段と、該指紋特徴データを通信ネットワークに接続して前記データベースに照合した結果を前記端末器に通知する手段を備え、指紋照合に応用したので遠隔地での利用もできる。

【0035】又、請求項16に係る発明は、医療又は社会福祉又はサービス業又は行政又は金融機関の本人履歴データ検索、施錠、各種発券、出札、改札、検札、検問、課金、電子商取引、資産管理運用のうちの何れかの機能を有する端末器又は単独の装置に組み合わせて配設し、指紋照合を本人確認手段として使用するようにしたので、従来はカード、鍵、切符、定期券、署名、印鑑、バッジ、顔及び本人の声で判別していた本人確認を瞬時の指紋照合だけで済ませられる。

【0036】又、請求項17に係る発明は、ソフトウェアの秘密保護、又は製造委託LSIの設計データ秘密保護の機能の一部として、秘密保護の対象品自体に埋め込む構造により配設し、指紋照合を本人確認手段として使用するようにしたので、秘密保護管理のコスト削減になる。

【0037】又、請求項18に係る発明は、複数の指の指紋特徴データを複数の指の指紋特徴データの論理演算により本人確認の規則を設定した。このようにしたことにより、家族限定等と適宜複数の人を権利者の許容範囲として自在に設定できる。例えば自動車事故損害賠償責任保険における家族限定等の特約事項に適合する自動車運転施錠装置に利用できる。又、1人で20指有るので、その級数計算である組み合わせは暗唱番号よりもバラエティーに富み、しかも保護対象への保護効果は絶大に強化される。

#### 【0038】

【発明の実施の形態】以下、図面に沿って、本発明による実施の一形態について説明する。図1は本発明の実施の一形態を示す、特徴弦の数値化の説明図である。図1において、特異点30から滑らかな曲線である隆線40が伸びている。ここでは湾曲方向がS字状に反転しない弧を想定している。その隆線40の延長方向を単位長さの弦41, 42, 43, 44でたどって順次1単位長さづつサンプリング点（以下、「測定点」とも称す）31, 32, 33, 34を付しながら前記隆線40の末端まで進行する。これは地図における曲線区間の道のりをデバイダで測定する要領である。そして、前記特徴弦の定義に基づき、特異点30から2点先のサンプリング点32まで連続する3点即ち30と31と32を直線で結んだ二等辺三角形の底辺51の長さを特徴弦として抽出する。

【0039】前記二等辺三角形にとらわれない説明によれば、特異点30から31, 32, 33と順次1単位づつ測定点を進めながら、それらの測定点からそれぞれ2単位先の測定点33, 34, 35までのそれぞれの弦の長さを計測する計測手段、即ち特異点30から第2の測定点32までの弦の長さ51、第1の測定点31から第3の測定点33までの弦の長さ52、第2の測定点32から第4の測定点34までの弦の長さ53を順次計測する。これらの計測結果51, 52, 53でなる数値群データをもって隆線40の曲線形状を示す情報とし、その単純な数値群データを指紋特徴データとする。その指紋特徴データを、予め構築されたデータベースの内容と比較することにより指紋を照合するようにし、少ないメモリ容量で照合速度及び照合率を高めるようにしている。

【0040】次に図2は識別すべき曲線40が移動し回転した図である。ここで、曲線40が前記数値化して認識されていれば、その曲線40が移動したり、反転したりしても弦51, 52, 53の長さは変わらない。従って、これらの弦51, 52, 53の長さでなる数値データにより曲線40の形状を認識、保存、再現及び識別でき、たとえ鏡に映したようにさかさまになっていても、数値データが一致すれば照合可能である。

【0041】次に図3は画素の隙間部分に存在する測定点の座標値を近似計算する原理の説明図である。デジタルカメラやビデオムービー等の撮像素子の撮像面においては、人の肉眼の網膜のように光に反応する微小な区画である画素が緻密に所定の数と面積を占めて並べられている。しかし、前記画素は巨視的には緻密であっても、微視的には所定の間隔を持って規則的かつ有限に配列されている。

【0042】ところで、コンピュータ等で処理するデジタル画像の場合、図3に示すように画面のデータは碁盤目状に配置された画素の上の点だけのデータで表される。これらの画素の中で模様が付けられた画素は曲線を表す画素であるとする。従って、ある画素100から例えば長さ4画素分の曲線上にあると推定される点12が実際の画素点であるとは限らない。そこで、4画素分の長さに近い曲線上の2つの画素の位置10, 11に関する情報から、4画素分の長さの距離が離れた曲線上の測定点12を計算することが必要となる。例えば、単純な比例配分に基づく直線近似によって当該の測定点の位置を計算することができる。このように画素の位置10, 11とは異なる測定点12から、図1に示す弦51, 52, 53の長さを求めることができる。

【0043】ここでは、前記測定点12が前記間隔の位置に存在する場合に、曲線40上のある基準点100から規定の直線距離99にある曲線40上の測定点12の座標を算出する手段として測定点算出アルゴリズムを備えている。そして、有限の分解能でしかありえない撮像面等、即ち拡大して見れば隙間だらけに配列された視覚

機能を有する複数の画素の隙間部分に存在して見落とされる点をも、計算上は厳密に推定できれば、理論的には無限の分解能を追求できる。

【0044】ここで、基準点100から直線距離99より近くにある第一の画素位置10と基準点100から直線距離99より遠くにある第二の画素位置11と基準点100とを結ぶ三角形を想定する。そして、基準点100と第一の画素位置を結ぶ線分を第一辺、基準点100と第二の画素位置11を結ぶ線分を第二辺、第一の画素位置10と第二の画素位置11を結ぶ線分を第三辺と夫々称し、その第一辺と第二辺の長さ及び直線距離99との比率により、前記第三辺を比例配分することによって前記座標を特定すべく近似計算する。この近似計算の精度いかんにより、格段に曲線識別能力が向上する。

【0045】図4は特徴点の方位角と曲率を用いた曲線形状システムの説明図である。図4に示す隆線400が分岐している分岐点401において、分岐の反対方向に伸びる隆線400を考える。まず分岐点401自身を第一の軌跡点とし、この第一の軌跡点からある距離Dだけ離れた隆線400上の点を第二の軌跡点402とする。さらに、第二の軌跡点402から同じく、距離Dだけ離れた隆線400上の点を第三の軌跡点403とする。同様の操作で第四の軌跡点404、第五の軌跡点405を求める。ここでの軌跡点401～405は、隆線400が途中で途切れるまでは、任意に増やすことができる。次に、これらの軌跡点401～405を順々に直線分、即ち弦501～504で結ぶことによって、隆線400の曲線形状と同じ長さDを持つ直線分、即ち弦501～504が連結したもので近似する。

【0046】この直線分、即ち弦501～504で近似された隆線400の曲線形状を、効率良く表現する方法は、まず分岐点401と第二の軌跡点402を結ぶ直線分が基準座標軸407となす角度(以後、これを特徴点の「方位角」と呼ぶ)を計算し、次に分岐点401と第二の軌跡点402を結ぶ直線と、第二の軌跡点402と第三の軌跡点403を結ぶ直線とがなす角度409を計算し(以後、これを特徴点の「第一の曲率度」と呼ぶ)、さらに、第二の軌跡点402と第三の軌跡点403を結ぶ直線と、第三の軌跡点403と第四の軌跡点404を結ぶ直線とがなす角度、即ち第二の曲率度410、以下同様に、隣接する二つの直線分がなす角度を順次求め。ここで、隆線の曲線形状を表現するために必要な情報は、特徴点の方位角408と、隣接する複数の直線分、即ち弦501, 502, 503, 504のなす角度である第一、第二及び第三の曲率度409, 410, 411だけである。

【0047】これら特徴点、即ち分岐点401及び軌跡点402～405の方位角408と曲率度409～411という情報を、特徴点を含む隆線に関する曲線形状の表現方法とし、この表現をもとに指紋照合を行うことに

よって、異なる指紋の識別能力が格段に向上することが期待できる。なお、この曲線形状の表現方法は、図4で示す隆線が分岐している特徴点の他に、隆線が断続している端点(図7参照)からなる特徴点にも同じく適用できる。

【0048】図5は細線化とポジネガ反転による真の特異点抽出アルゴリズムである。細線化処理(ステップS7)と、疑似特異点補正(ステップS8)により縦列接続処理部となし、その縦列接続処理部に原白黒画像を通過させる。又、前記原白黒画像のうち黒色面オブジェクト(一括りの輪郭線囲い)の長手方向の枠線のみを生かして、幅を1画素分にすることにより、面を線に変換するアルゴリズムが細線化処理(ステップS7)として示されており、前記黒色面オブジェクトを線分だけにまで簡素化する。尚、具体的な細線化処理(ステップS7)の様子は図8に沿って後述する。

【0049】そして、第1の分類の前記端点のみを抽出する1回目の端点抽出処理と、その第1の端点抽出処理により抽出した信号を白黒反転させるポジネガ反転(ステップS70)と、その白黒反転した信号が都合2回だけ、前記縦列接続処理部を通過したことを、処理回数確認(ステップS72)により確認され、そして得られる第2の分類の前記端点を抽出する第2の端点抽出処理をなすことにより、前記原白黒画像の隆線における端点と分岐点の両方を得られる特異点抽出手段となし、指紋照合に応用できるようにしている。このことは、後ほど図8により詳しく説明する。

【0050】このようにしたことにより、二股に分岐する前記隆線を白黒反転処理に伴って、画像構成を究極まで簡素化し、分岐も交差もしない単純曲線の集合だけとなる画像構成とし、その簡素化された画像構成で指紋照合するので、膨大な試料数の機械照合に最適となり、従来よりも少ないメモリ量を初めとする簡素な設備により、高速かつ正確な指紋照合が可能となる。

【0051】図6はグレースケール画像改善手段まで含めた真の特異点抽出アルゴリズムである。ブロック細分化手段により複数に分割され細分化されたブロック画像のコントラストを強めて白黒に二値化して二値化処理画像を得る第1の二値化処理(ステップS3)を行い、その二値化処理画像から前記指紋の凸条模様即ち隆線の方向を検出する隆線方向検出(ステップS4)を行う。

【0052】そして、隆線方向検出(ステップS4)により、隆線の方向を求め、ノイズ成分を除去する際の補助情報として利用する。即ち、前記隆線の方向に沿った線の画像情報を有効と判断し、前記隆線の方向に沿わない画像情報をノイズと判断し、そのノイズを除去して改善画像を得るグレースケール画像改善(ステップS5)に至る。尚、二値化は曖昧な中間値でなるアナログ電気信号をデジタル化する常套手段であるが、ここでは、8ビット等の複数ビットで表されたデジタル電気信号

を1ビットのデジタル電気信号に変換する手段であり、ある基準値との間の大小比較操作による。

【0053】ここで、図7は疑似特異点の説明図であり、

(a) 同じ方向の隆線を持って近接する端点(20)の説明図である。

(b) 分岐点に近接する端点(21)の説明図である。

(c) 画像の枠に近接する端点(22)の説明図である。

前記指紋データからノイズ成分を補正する疑似特異点補正(ステップS8)を経て真の特異点抽出(ステップS9)に至る。この疑似特異点補正(ステップS8)の具体的手段はポストプロセッシングであり、図7に沿って説明する。図7(a)(b)(c)はノイズ成分等により間違って捕らえられ、特異点でないにもかかわらず特異点だと誤認されてしまった3種類の疑似特異点の説明図であり、画像の枠若しくは分岐点に近接する端点、又は同方向の隆線を持って近接する端点を、ノイズで隆線が欠落して発生した疑似特異点と見なして連結する補正規則が前記ポストプロセッシングとして疑似特異点補正(ステップS8)に適用されている。

【0054】そして再度、図6に説明を戻し、前記改善画像のコントラストを強めて白黒に二値化し二値化処理画像を得る第2の二値化処理(ステップS6)を行い、その二値化処理画像において、複数の画素幅からなる前記隆線、即ちある幅を持った隆線をその画素幅の中心に向かって幅圧縮することにより、単一の画素幅にまで細線化した隆線に変換する細線化処理(ステップS7)を施す。細線化処理(ステップS7)は、複雑な形状の画像をより単純化し、数値化及び機械計算処理に適合させて、照合作業を簡素にする作用がある。

【0055】次に、同方向の隆線を持つ近接する端点20若しくは分岐点に近接する端点21、又は画像の枠に近接する端点22を、ノイズで前記隆線が欠落して発生した疑似特異点と見なして連結する疑似特異点補正(ステップS8)をおこなう。以上、図6において、入力画像に対する一連の画像処理により、疑似特異点補正まで施した後の前記隆線の端点及び分岐点を、真の特異点と見なして抽出する(ステップS9)特異点抽出手段を備え、指紋照合に応用した。このようにしたことにより、ノイズを含む指紋の入力画像に対しても、高い照合率で指紋照合ができる。

【0056】そして、図8は白黒反転と細線化による特異点抽出法の説明図であり、(a)は処理前の白黒ブロック画像の説明図、(b)は中途処理の抽出特異点の説明図、(c)は白黒反転ブロック画像の説明図、(d)は最終処理後の抽出特異点の説明図である。既に図5に沿って説明した細線化処理(ステップS7)とポジネガ反転(ステップS70)による真の特異点抽出アルゴリズムであるが、細線化処理(ステップS7)により図8

における(a)から(b)の画像処理となり、これだけでも処理前に比べれば格段に情報量を低減しているものの、二股分岐点の数値化には負担が残る。図8(b)では同(a)に対して相当に情報量の軽減しているものの、分岐点を有するので、それが指紋照合の際に一意判断出来ないというネックになる。

【0057】そこで、前記二股分岐点を無くすように、ポジネガ反転(ステップS70)により図8における(a)から(c)の画像処理を施し、さらに細線化処理(ステップS7)により図8における(c)から(d)の画像処理となり、前記二股分岐点は有限曲線の一端、即ち特異点で表される。しかも、これらの処理を2回繰り返すことにより徹底している。このようにして、分岐点の無い有限曲線及び最終処理後の特異点を抽出すれば、分岐点を無くすことにより、さらに情報量を低減し、数値化も容易であり、その数値化情報の情報量は画像処理前に比べて絶対的に少なくてすむ。そして、指紋照合が一意的な判断事項に帰着し、人為的又は多項目に亘る判断が不要となるので、機械処理に適するようになり、処理が高速化し、かつメモリ容量も少なくて済み、データベースの構築及びその維持も負担が軽くなる。

【0058】図9は二次的な特徴点を用いた曲線識別システムの説明図である。図9に示すように、ある特徴点91に着目した時、その特徴点91に接続している隆線方向軸Y1と、その垂直な軸X1の座標軸上にあり、特徴点91から等距離の4点92、93、94、95を二次的な特徴点と見なし、これら二次特徴点の最近傍の隆線の形状RS1、RS2、RS3、RS4を、図4に沿って前記した曲線形状の表現方法を用いて抽出する。これら四つの二次特徴点隆線形状RS1、RS2、RS3、RS4は、もとの特徴点91から見た指紋全体の模様を断片的に捉えたものであり、この付加的情報を指紋照合に用いることにより、その照合精度を格段に向上させることが期待できる。したがって、始点を真の特異点から特定できる二次的な特異点を設定して、その点を始点とする隆線形状を指紋情報に付加することによって、適用範囲を大幅に拡大することを可能にしている。具体的には、特異点隆線形状だけでは登録できなかった指紋も、ほぼ100%登録し、照合できるようになった。

【0059】図10は内積を利用した擬似特異点の除去の判定に関する説明図である。図10に示すように、真の隆線の分岐点は、その分岐点を中心として、一つの狭い角度で囲まれた領域A101と二つの広い角度で囲まれた領域A102、A103に分割されているような形状を持つものがほとんどである。また、真の隆線の端点は、図8に示すように、谷線の分岐点と見ることができ、その場合、前記の隆線の分岐点と同様に、一つの狭い角度で囲まれた領域A101と二つの広い角度で囲まれた領域A102、A103に分割されているような形状を持つ性質がある。これらの性質を利用し、このよう

な隆線又は谷線の分岐点が分割している領域を、少ない計算量で判別するために、図10に示すように、分岐点101から等距離に離れた隆線上又は谷線上の点102, 103, 104を求め、分岐点を原点と見なした時の三つの点の二次元座標(Xa, Ya), (Xb, Yb), (Xc, Yc)を求める。

【0060】それから、点102と点103の対において、座標の水平成分の積(Xa・Xb)と垂直成分の積(Ya・Yb)を足した値(Xa・Xb + Ya・Yb)を求める(以後、この操作によって求まる値を「二点の内積値」と呼ぶ)。この二点の内積値は、分岐点101と点102を結んだ直線と分岐点101と点103を結んだ直線とがなす角度の余弦に比例するため、その値が大きければ、これら二つの直線分は狭い角度をなし、逆にその値が小さければ広い角度を持つことになる。同様に、点103と点104における内積値と、点104と点102における内積値についても同様の操作で求める。これら三つの内積値のうち、ある閾値よりも大きいものがちょうど一つある場合は、この分岐点が前記で説明した一つの狭い角度で囲まれた領域と二つの広い角度で囲まれた領域に分割していることを示し、真の分岐点であると判断し、これ以外の場合は、この分岐点は疑似分岐点であると判断する。

【0061】ある二つの指紋画像について、例えこれらの指紋が同一の指のものであっても、指を置く位置や角度によって、特徴点の位置や方向が変わってくるが、指紋照合を行う際には、この位置と方向のずれを特定した上で、適切な位置ずれ補正を施した後に、特徴点の比較を行う必要があった。このように、位置と方向のずれを特定し、適切な位置ずれ補正を施すためには、従来、膨大な計算量が必要であるとされ、そのために許容できる位置のずれや角度のずれには大きな制限が加わっていた。

【0062】以下に、平行移動のずれに関して、その位置ずれ補正を必要としない指紋照合の方法について説明する。まず、図11に示すように、ある大きさの長方形の広がりを持つ二次元空間を樹目状に分割し、それぞれの樹目がメモリ番地に対応した二次元構造のメモリ空間を持つ書き込み読み出し可能メモリを用意する。図11では、M個の行とN個の列からなる二次元配列構造のメモリ空間を示している。指紋照合処理の開始時には、このメモリの各メモリ番地には、予め決められた初期値(例えば零値)を格納しておく。

【0063】次に、二つの指紋からそれぞれ一つずつ選んだ特徴点の対について、それらの形状がどれだけ類似しているかという、類似度指標値を評価する。この類似度指標値を計算する評価関数は、特徴点における隆線方向やその曲線形状の類似度をもとに、類似度が高い場合には大きい値(例えば259)を、類似度が低い場合には小さい値(例えば1)を出力する性質をもつ関数を使う。

【0064】それから、前記の二つの特徴点について、一方の指紋に属している特徴点の二次元座標値(Xa, Ya)から他方の指紋に属している特徴点の二次元座標値(Xb, Yb)までを結ぶ二次元ベクトル(Xb - Xa, Yb - Ya)を求める。これは、前者の指紋が水平方向に(Xb - Xa)、垂直方向に(Yb - Ya)だけ平行移動した時に、ちょうどこれら二つの特徴点が同じ二次元座標上に位置することを意味する。もし、これら二つの特徴点の間の類似度指標値が高い値を持つ場合、実際の指紋の平行移動のずれが、前記二次元ベクトル(Xb - Xa, Yb - Ya)である可能性が高いことを示し、逆に類似度指標値が低い場合は、実際の指紋の平行移動のずれが(Xb - Xa, Yb - Ya)である可能性が低いことを示す。

【0065】次に、前記の二次元ベクトル(Xb - Xa, Yb - Ya)を二次元座標値と見なした時、この座標値が図11に示した二次元空間上のどの樹目に含まれるかを調べ、これを含む樹目に対応したメモリ番地に格納されている値をメモリから読み出し、その値に二つの特徴点の間の類似度指標値を加算した累積値を、再び同じメモリ番地に書き込む。

【0066】図11は平行移動に関するずれ補正を必要としない照合方法における、類似度指標値の累積値の格納メモリ領域の説明図である。前記説明で、特徴点対の類似度指標値の計算、二つの特徴点間の二次元ベクトルの計算、二次元ベクトルを二次元座標値と見なした時にその座標値が含まれる図11の樹目を特定し、その樹目に対応するメモリ番地に格納されている値1～259

(符号ではない)に類似度指標値を加算した累積値を同じメモリ番地に書き込む、という一連の操作を、二つの指紋からそれぞれ一つずつ選ばれる特徴点の対の、一部あるいはすべての組合せについて繰り返す。その後、各メモリ番地に格納されている類似度指標値の累積値のうち最大のもの(例えば259)を、これら二つの指紋の総合的な類似度指標値とする。この総合的な類似度指標値がある閾値よりも大きい場合は、同一の指紋であると判定する。この方法により、任意の平行移動に関するずれ補正が同時に処理されるため、極めて計算量の少ない指紋照合が実現できる。

【0067】これまででは、平行移動に関するずれ補正の必要としない指紋照合の方法を説明したが、ここでは、回転に関するずれ補正を行うことによって、任意の回転および平行移動のずれにも高精度な照合を可能にする方法について説明する。ある回転角に関するずれ補正是、照合する二つの指紋のうち一方の特徴点すべてに対してその角度の回転補正を施す。特徴点データは、前記の説明の通り、特徴点の二次元座標値とその特徴点形状情報からなるが、特徴点の二次元座標値については、基準原点を中心として、回転変換による補正を施し、特徴点形状情報については、特徴点方位角に対して同じ角度を補正する。なお、特徴点形状の曲率を表現する情報に関し

ては、回転移動についても不变であるため、補正を必要としない。このようにして、前記の回転補正を一方の指紋の特徴点すべてに施した後、前記説明の平行移動に関する位置ずれ補正の必要なない指紋照合によって照合を行う。

【0068】図12はラスタースキャン及び全画面の数値化による認識処理の特異点抽出アルゴリズムである。テレビカメラ映像入力（ステップS1）は周知のラスタースキャンのテレビ方式によるものなので、1フレームの画面を所定の時間、例えば25分の1秒もしくは30分の1秒で走査し、各画素及び各ブロックデータを所定の順番によって認識し、1フレームの全画像情報を溜めることなく、局的に部分ブロックデータを保存（ステップS92）する。以降、図5及び図6で示した、特異点抽出処理（ステップS93）を限られた短時間で行う。

【0069】ただし、特異点抽出処理（ステップS93）には毎秒一億命令実行可能なコンピュータが動作し、1つの指紋画像あたり50バイト前後の前記指紋特徴データを割り当てたとして、一枚の指紋画像を特異点抽出処理（ステップS93）及び特異点データ保存（ステップS94）を局的に順次実行し終わるのに約5分の1秒程度を要する。尚、前記約5分の1秒程度とは実際には0.24秒であるが説明の便宜上、分数表示しており、25分の6フレーム又は30分の6乃至7フレームをスキャンするのに要する時間である。従って、5又は6乃至7フレームのラスタースキャンすれば、前記約5分の1秒に相当するので、前記一枚の指紋画像全体に亘って特異点抽出処理（ステップS93）及び特異点データ保存（ステップS94）が完了し、全画面処理の確認（ステップS95）は完了と判断され、1つの指紋画像の認識処理の完了となる。

【0070】そして、図13は本発明の一実施形態として示した指紋照合システムのアルゴリズムである。テレビカメラ映像入力（ステップS1）乃至真の特異点抽出（ステップS9）、そして全画面処理の確認（ステップS95）までのアルゴリズムは、既に図5、図6及び図9に沿って略説明済みの内容を連結したものである。

【0071】又、テレビカメラ映像入力（ステップS1）の直後のブロック細分化（ステップS2）がこの実施形態では必須要件であり、複数に分割され細分化されたブロック画像を二値化処理（ステップS3）及びグレースケール画像改善（ステップS5）へと至らせる。又、全画面処理の確認（ステップS95）の結果が「はい」なら照合処理（ステップS74）又は指紋照合データベースへの格納（ステップS75）に至る。尚、照合処理（ステップS74）の際には数値化されたデータの状態で指紋照合データベースの照合見本データと比較照合される。

【0072】尚、前記ブロック画像のつなぎ目には碁盤

目状のノイズが発生する（図示せず）ので、ソフトウェアによりそのノイズを除去するが、そうしても必要な情報は欠落せずに、全画面分の情報を確保し又は補足できるように、隣接するブロック間では互いにオーバーラップさせている。

【0073】このようにして、1秒間に1億命令を実行するコンピュータは、入力された指紋画像のノイズ除去、画像改善、二値化、細線化、疑似特異点除去及びデータベースとの照合の一連の操作を0.24秒で実行し、1つの指紋画像に対する前記指紋特徴データを40乃至60バイトのデータ量で識別可能に処理する。

【0074】又、画質改善及び各種処理に関し、さらに説明する。図6及び図13に示したように、画像分割する以前の指紋画像から、隆線方向検出（ステップS4）により隆線方向の情報を抽出し、図示しない方向性フィルタを制御し、前記グレースケール画像改善（ステップS5）を利用している。ここで、指紋画像が方向性フィルタへ入力され、これが一般的な指紋の形状から明らかに逸脱する程の修正を要する箇所があれば、そこを前記隆線方向の情報に沿って、指紋らしい形状になぞった線を書き足すように情報修正し、より鮮明な画像に改善する。要するに、人の肉眼により要修正箇所を発見し、その周囲の隆線方向から憶測して手修正を加えることに匹敵する修正をソフトウェアで自動的に実行するように信号処理プロセッサ（以下、DSPとも称す）のプログラムにより実施している。

【0075】又、ブロック細分化はラスタースキャン方式のテレビ画面を碁盤目状に区分して、各ブロック画像毎にデータ処理すれば、機械には不得手である複雑な画像情報の処理を単純化し、一意処理に近づけられる。何故ならば、一つの指紋画像を拡大すれば、その隆線形状は単純化し、特異点との関係でのみ簡素に書き表せる線画になり、機械での一意処理による認識も可能となるからである。

【0076】従って、テレビ画面に一つの指紋画像を大写しに構図し、それを各ブロック画像に分割したならば一意処理に近づけられる。但し、前記各ブロック画像の情報の全部を記憶させるわけではなく、指紋照合に寄与し、回転、移動、ノイズに強い局的な特異点30とそれによつわる特徴弦51、52、53の抽出をまでを、前記各ブロック画像を読み取った直後にその都度、局所的完結データ処理しながら、その処理時間を費やす間にラスタースキャンが進んで移動した画像読み取り部（図示せず）に対応するブロック画像の情報は読み飛ばしている。要するに考えている間は読まないのである。そうすることによって、必要なメモリ容量を少なく抑えられる。具体的には、小型テレビカメラと、図示しない信号処理プロセッサ（DSP）を接続したシステム構成である。DSPのプログラムには、本発明のアルゴリズムがプログラムの形で備えられている。

【0077】前記小型テレビカメラからラスタースキャン方式で取り込む $200 \times 200 = 2$ 万画素である前面を $32 \times 22$ 画素の小ブロック画像毎にDSPのデータメモリに一時格納し、直ちに測定点31, 32, 33, 34をサンプリングしながら隆線40に沿って設定し、特異点隆線情報即ち指紋特徴データに数値化する。このようにして、数値化され抽出された指紋特徴データは図示しないデータメモリに格納する。

【0078】そして、次に入力される小ブロック画像のデータについて同様の処理を行う。又、前記DSPが特徴弦51, 52, 53を抽出するのに時間を要するため、連続したブロックの処理は行えない。即ち、コンピュータが考えながら特異点隆線情報を数値化するのに忙しく、その間は新規情報を読み込まないようにして、メモリ容量の節約を図っている。

【0079】このシステムでは、前記小ブロック画像の処理は独立して実行できるので、例えば毎秒25フレーム（欧州とロシアのPAL又はSECAM方式テレビ）のスピードのスキャンで、6フレームの指紋画像を入力し、全体として全ての画像領域をカバーするようにしている。逆に言えば、1フレームの指紋画像から全ての画像領域の $1/6$ より少しだけ多く（前記オーバーラップ分）の画像データを読み取っている。

【0080】1フレームの指紋画像から全ての画像領域をカバーしようとしても、前記DSPが指紋照合に必要最小限の前記特異点隆線情報を数値化するのに0.24秒程度を要するので、1フレームをスキャンする $1/2.5$ 秒又は $1/3.0$ 秒（日米のNTSC方式テレビ）ではカバー出来なくなる。そこで6乃至7フレーム分の時間、即ち $6/2.5$ 秒又は $7/3.0$ 秒に跨がって1組の指紋画像情報を前記小ブロック画像毎に間欠的に捕捉し、その都度加工しながら機械が指紋照合するのに都合の良い、略一意的な数値情報を即ち指紋特徴データにしてデータベース化している。

【0081】ここで、指紋照合システムの実際の運用方法に際し、先ずは照合対象となる多数の指紋特徴データをホストコンピュータ又は情報センタのデータベースに登録する。次に本人確認のために撮像した指紋画像から指紋特徴データを抽出して指紋照合に用いる。前記データベースに登録され、照合対象となる多数の指紋特徴データと照合し、予め定められた照合度合い判定基準により、「真」か「偽」の判定する。

【0082】例えば、指紋照合の正しさの尺度として、正しく照合する確率として、「照合率」があり、「真」と判定されたサンプルの中に含まれる、「真」の指紋の割合であり、100%であることが理想であるが、これを100%にこだわると一切のノイズ成分を含まない完璧な指紋照合でなければ判定出来ないことにもなり、かなりの高い確率で、登録指紋を受け付けられない。

【0083】さらにそれだけでなく、「真」の指紋であ

るにもかかわらず、誤って「偽」の判定をする「不照合率」があり、「偽」と判定されたサンプルの中に含まれる、「真」の指紋の割合であり、0%であることが理想であるが、前記「照合率」を100%に設定すれば、数%程度の前記「不照合率」となる。これらの概念は自動販売機等におけるお札の「真」か「偽」の判定照合システムそのものにも見られる、「真偽判定照合感度」の設定と同様であり、実用上、妥協できるレベル設定が成される。

【0084】本発明によれば前記「照合率」を100%に設定しても、前記「不照合率」を僅か1.2%に抑えることに成功した。これは従来の世界最高の指紋照合システムの同「不照合率」が27.72%であったことに比べれば画期的成功と言える。このことは、特に回転、移動、ノイズのある入力指紋画像に対して、識別能力が高くなったことも意味する。

【0085】又、前記指紋特徴データの収集及び照合の一連のデータ処理を、毎秒1億命令実行可能な信号処理プロセッサを有するコンピュータが動作し、1つの指紋画像あたり50バイト前後の前記指紋特徴データを割り当てる前記照合手段により識別すれば、入力画像のノイズ除去、画像改善、2値化、細分化、照合の一連の操作を0.24秒で処理できる。このことは実用レベルとしては従来のものよりも格段に高速かつ確実な照合ができたと言える。

【0086】又、通信ネットワークに接続し、データベースの具備された情報センタと情報通信すれば遠隔地でも本人確認できる。

【0087】又、複数の指の指紋特徴データを複数の指の指紋特徴データをAND、NAND、OR、NOR等の組み合わせでなる論理演算により本人確認の規則を設定した。このようにして、父、母、子供たち全員の各親指の指紋データをORで使用許可する設定すれば、家族共通の施錠にちょうど良く、自宅の施錠を初めとして家族限定等と適宜複数の人を権利者の許容範囲として自在に設定でき、例えば自動車事故損害賠償責任保険における家族限定等の特約事項に適合する自動車運転施錠装置に利用できる。又、1人で20指有るので、その級数計算である組み合わせは暗唱番号よりもバラエティーに富み、しかも保護対象への保護効果は絶大に強化される。例えば、右親指と左人差し指のANDに適合したら許可の条件にする。そして、万が一指紋データを守秘義務者等が故意又は過失で漏らし、又は盗用された場合は、そのことを本人が察知した時点で速やかに前記組み合わせを左右の小指のAND等に変更すれば被害の拡大を阻止できる。

【0088】尚、米国の電子商取引における改正法の下で、たとえ「暗唱番号が署名と同等の法的効果を有する」という環境になっても、本人確認機能に関する常識的かつ究極的判断としては指紋の方を暗唱番号よりも上

位に位置付けられることが必至である。

【0089】

【発明の効果】以上説明したように曲線識別システムを構成したので、請求項1に係る発明によれば、少ないメモリ容量で曲線を表すことができる。従って、湾曲の方向が反転しない曲線であれば、曲線の長さと形状を計測データの数値群のみによって正確に記憶、再生、又は照合できる。しかも、試料を移動又は回転させても支障なく曲線の識別ができる。即ち、この曲線を表すデータ形式は、移動や回転に強い曲線形状の表し方である。一般に、数値群のみの比較であれば、人よりも機械の方が断然有利である。これらのこととは、人にはできても機械には比較的困難とされていた、「ものの形状パターン認識」を略完全に機械に置き換えて、なお余りあるほどの膨大なデータベースを高速かつ正確に処理できる効果をもたらす。

【0090】又、請求項2に係る発明によれば、有限の分解能でしかありえない撮像面等、即ち拡大して見れば隙間だらけに配列された視覚機能を有する複数の画素の隙間部分に存在して見落とされる点をも、計算上は厳密に推定できるので、理論的には無限の分解能を追求できる。

【0091】又、請求項3に係る発明によれば、S字状に湾曲の方向が反転する曲線であっても、その曲線の湾曲方向まで特定しながら形状を識別し、数値から曲線への再現も完全に可能となり、さらに認識画面上で回転した曲線をも、方向を示す数値以外の数値が一致していれば、似た形状の曲線でありながらも、それらの違いを、識別することが可能となる。逆説的には、単に回転したに過ぎないであろう一見して類似形状の曲線を照合すれば、同一の曲線形状であることを断定できる。

【0092】又、請求項4に係る発明によれば、認識画面上で曲線が移動した位置を示す数値の違いによってそのことを識別することが可能となる。逆説的には、単に移動したに過ぎないであろう一見して類似形状の曲線を照合すれば、同一の曲線形状であることを断定できる。

【0093】又、請求項5に係る発明によれば、ノイズを含む指紋の入力画像に対しても、高い照合率で指紋照合ができる。

【0094】又、請求項6に係る発明によれば、特異点隆線形状だけでは登録できなかった指紋もほぼ100%登録し、照合できるようになった。

【0095】又、請求項7に係る発明によれば、膨大な試料数の機械照合に最適となり、従来よりも少ないメモリ量を始めとする簡素な設備により、高速かつ正確な指紋照合が可能となる。

【0096】又、請求項8に係る発明によれば、ノイズによって発生する疑似特異点を少ない計算量と高い精度で真の特異点から区別することが可能になった。

【0097】又、請求項9に係る発明によれば、メモリ

容量を浪費していた指紋画像全体の生画像データ、即ち情報量削減処理のなされる以前の画像情報をためること無く、少ないメモリ容量でシステム構成できる。

【0098】又、請求項10に係る発明によれば、指紋の平行移動のずれ補正を平行移動操作と比較という探索を行わないので、極めて高速な指紋照合が実現可能となった。

【0099】又、請求項11に係る発明によれば、指紋の回転移動のずれ補正を回転移動操作と比較という探索を行わないので、極めて高速な指紋照合が実現可能となった。

【0100】又、請求項12に係る発明によれば、実用性を維持しながら設備の簡素化を実現できる。

【0101】又、請求項13に係る発明によれば、少ないメモリ容量で照合速度及び照合率を高めることができ、実用レベルとしては従来のものよりも格段に高速かつ正確な照合ができる。

【0102】又、請求項14に係る発明によれば、さらに大幅なメモリ領域の削減と高速での照合ができる。

【0103】又、請求項15に係る発明によれば、遠隔地での指紋照合の利用もできる。

【0104】又、請求項16に係る発明によれば、従来はカード、鍵、切符、定期券、署名、印鑑、バッジ、顔及び本人の声で判別していた本人確認を瞬時の指紋照合だけで済ませられる。

【0105】又、請求項17に係る発明によれば、秘密保護の対象品に対する秘密保護管理のコスト削減になる。

【0106】又、請求項18に係る発明によれば、家族限定等と適宜複数の人を権利者の許容範囲として自在に設定できる。例えば自動車事故損害賠償責任保険における家族限定等の特約事項に適合する自動車運転施錠装置に利用できる。又、1人で20指有るので、その級数計算である組み合わせは暗唱番号よりもバラエティーに富み、しかも保護対象への保護効果は絶大に強化される。

【図面の簡単な説明】

【図1】特徴弦の数値化の説明図である。

【図2】識別すべき曲線が移動し回転した図である。

【図3】画素の隙間部分に存在する測定点の座標値を近似計算する原理の説明図。

【図4】特徴点の方位角と曲率を用いた曲線形状システムの説明図である。

【図5】細線化とポジネガ反転による真の特異点抽出アルゴリズムである。

【図6】グレースケール画像改善手段まで含めた真の特異点抽出アルゴリズムである。

【図7】疑似特異点の説明図であり、

(a) 同じ方向の隆線を持って近接する端点の説明図である。

(b) 分岐点に近接する端点の説明図である。

(c) 画像の枠に近接する端点の説明図である。

【図8】白黒反転と細線化による特異点抽出法の説明図であり、

(a) 処理前の白黒ブロック画像の説明図である。

(b) 中途処理の抽出特異点の説明図である。

(c) 白黒反転ブロック画像の説明図である。

(d) 最終処理後の抽出特異点の説明図である。

【図9】二次的な特徴点を用いた曲線識別システムの説明図である。

【図10】内積を利用した擬似特異点の除去の判定の説明図である。

【図11】平行移動に関するずれ補正を必要としない照合方法における、類似度指標値の累積値の格納メモリ領域の説明図である。

【図12】ラスタースキャン及び全画面の数値化による認識処理の特異点抽出アルゴリズムである。

【図13】指紋照合システムのアルゴリズムである。

【符号の説明】

10 第1の画素位置

11 第2の画素位置

12 測定点

20, 21, 22 端点

30 特異点

40, 400 曲線又は隆線

41, 42, 43, 44 単位長さの弦

12, 31, 32, 33, 34 測定点

51, 52, 53 特徴弦

91 特徴点

92~95 二次特徴点

99 規定の直線距離

100 基準点

101, 401 分岐点

102, 103, 104 隆線又は谷線上の点

402~405 軌跡点

407 基準軸

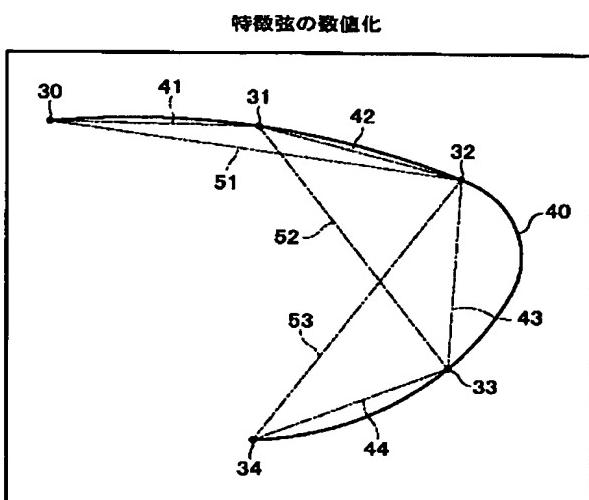
408 特徴点の方位角

409, 410, 411 曲率度

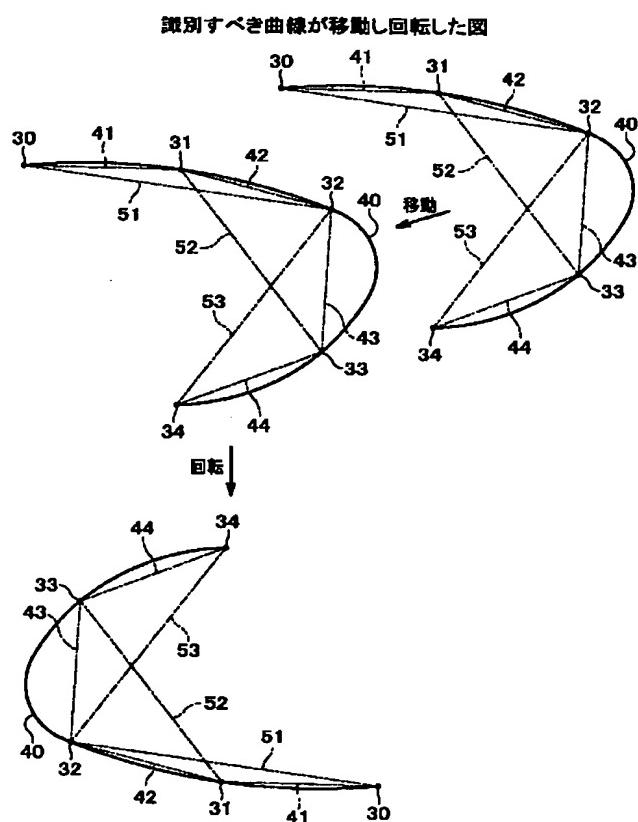
501~504 長さDの弦

R S 1~R S 4 二次特徴点を始点とする隆線の形状

【図1】

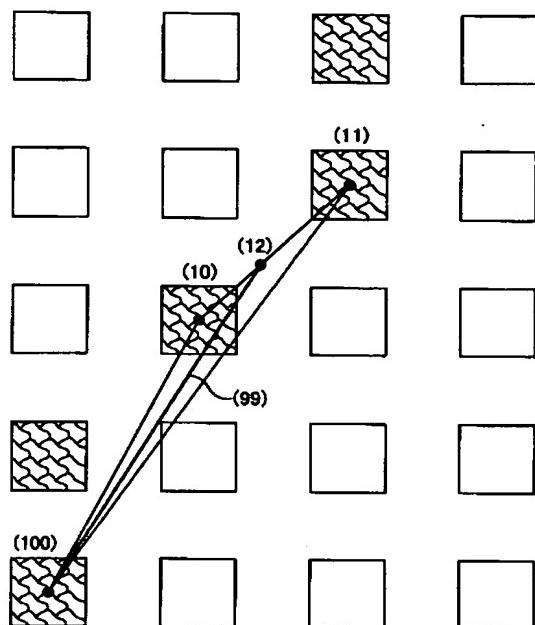


【図2】

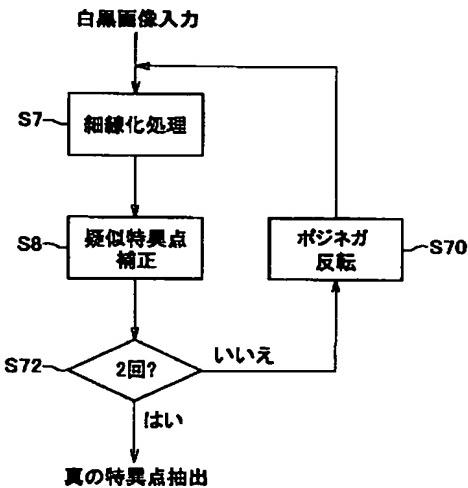


【図3】

画素の隙間部分に存在する測定点の座標値を近似計算する原理 細線化とポジネガ反転による真の特異点抽出アルゴリズム



【図5】



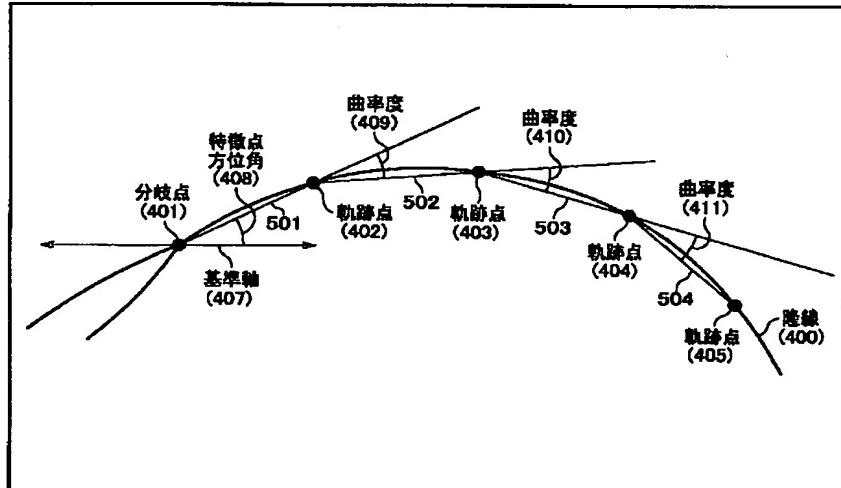
【図7】

#### 疑似特異点

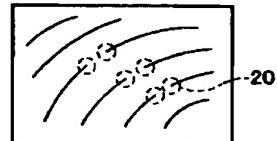
(a) 同じ方向の陸縫を持つ近接する端点

【図4】

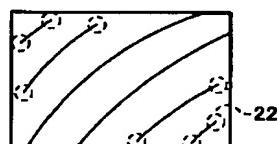
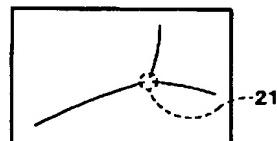
#### 特徴点の方位角と曲率を用いた曲線形状システム



(b) 分岐点に近接する端点

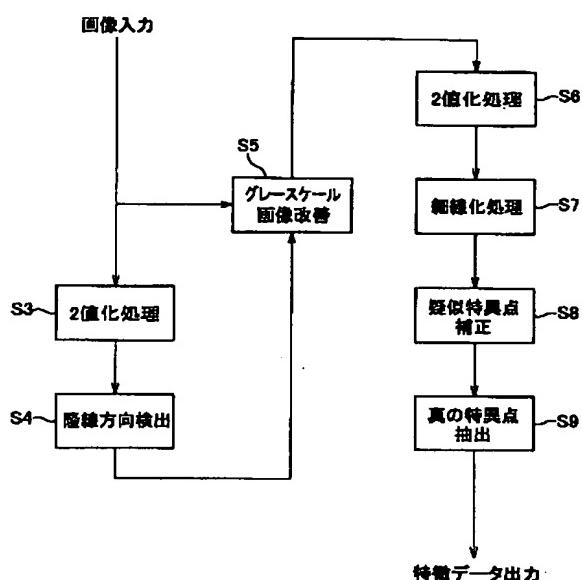


(c) 画像の枠に近接する端点



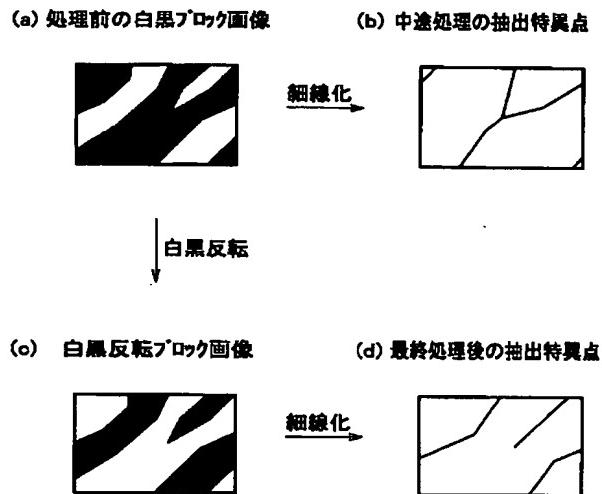
【図6】

グレースケール画像改善手段まで含めた眞の特異点抽出アルゴリズム



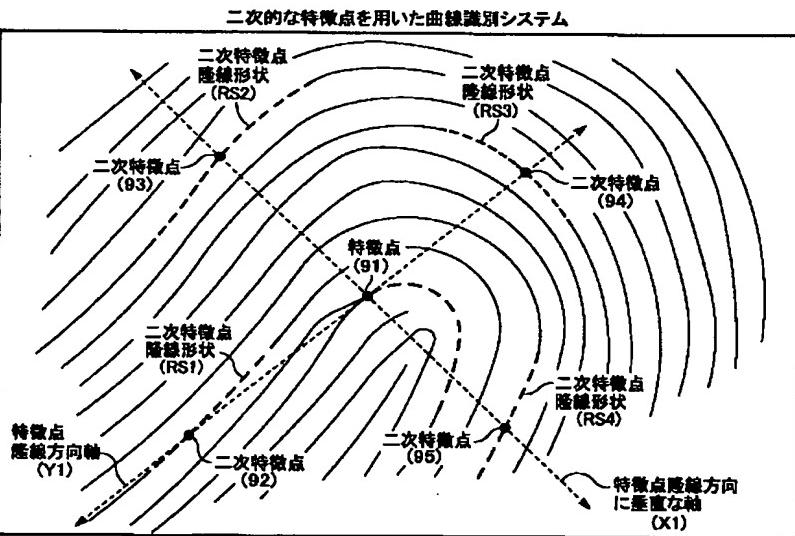
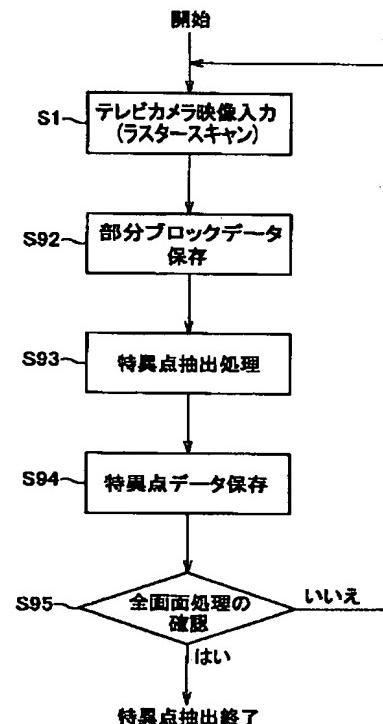
【図8】

白黒反転と細線化による特異点抽出法

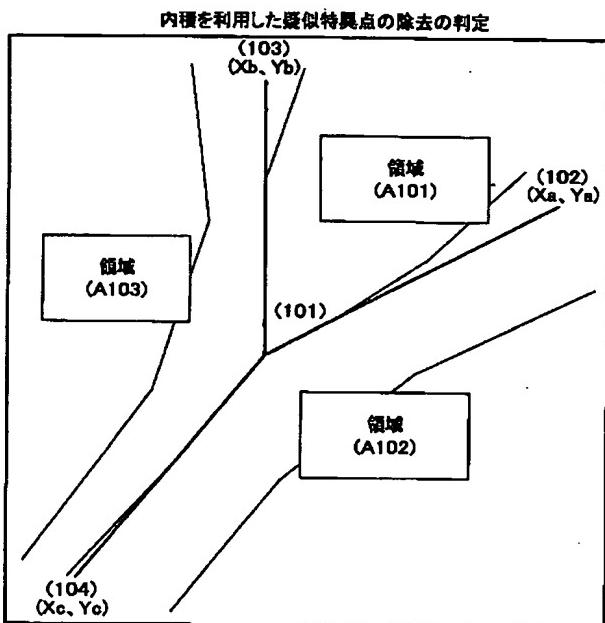


【図12】

【図9】

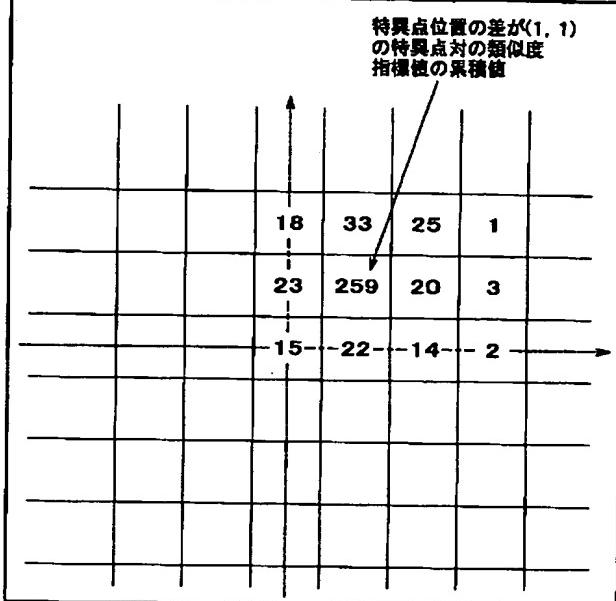
ラスタースキャン及び全面面の数値化による  
認識処理の特異点抽出アルゴリズム

【図10】



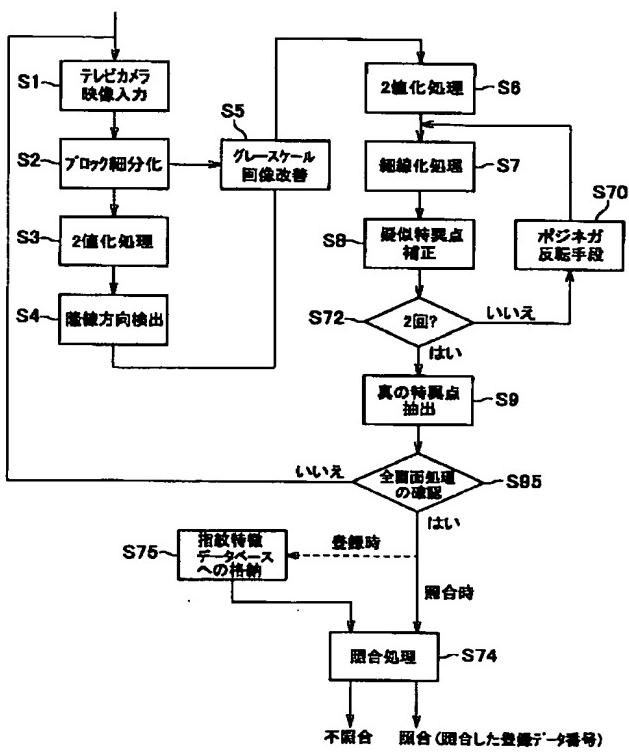
【図11】

平行移動に関するずれ補正を必要としない照合方法における類似度指標値の累積値の格納メモリ領域



【図13】

指紋照合システムのアルゴリズム



フロントページの続き

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(54) CURVE IDENTIFICATION SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To realize a curve identification system capable of locally and fragmentally recognizing and processing the image information of a curve and specifying the curve even when rotated and moved and moreover resistant to noise in the curve identification system with restrictions on image processing capacity.

**SOLUTION:** Elements of high importance such as curve shape, inclination and a position, in a curve image are all expressed in simple numeric values, and the retention and collation of the numeric value data are performed accurately at high speed by a simple device. The system is provided with an algorithm that can digitize the curve shape by the length of a plurality of chords formed by suitably connecting the sampling points formed on the curve by chords of equal space extended along the curve, and the inclination, position, and the like by coordinates.

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CLAIMS

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[Claim(s)]

[Claim 1] It goes on to the end of said curve (40), following the extended direction of the curve (40) which starts at the singular point (30) as a data format showing a curve by the bowstring (41) of unit length, (42), (43), and (44), and attaching point of measurement (31), (32), (33), and (34) at a time one by one.

[ with an unit length of 1 ] The curvilinear discernment system characterized by carrying out storage of a curvilinear configuration, playback, or collating to the measurement means which carries out sequential measurement of the die length of the bowstring (51) by said singular point (30) and the point of measurement of said each point of measurement to 2 unit point, (52), and (53) by the numerical group of the measurement data.

[Claim 2] In the image-processing algorithm which changes into said numerical group the image which consists of two or more pixels macroscopically arranged regularly with predetermined spacing precisely and microscopically When point of measurement (12) exists in the location of said spacing, as a means to compute the coordinate of the point of measurement (12) on said curve which is in a regular slant range (99) from a certain reference point (100) on said curve The triangle which connects the second pixel location (11) and said reference point (100) which exists in the distance from a regular slant range (99) from the first pixel location (10) and said reference point (100) which is in near from a regular slant range (99) from said reference point (100) is assumed. With a ratio with the die length of the first side which connects the first pixel location (10) to said reference point (100), and the second side which connects the second pixel location (11) to said reference point (100), and the slant range (99) of said convention The curvilinear discernment system according to claim 1

characterized by having the point-of-measurement calculation algorithm which carries out an approximation calculation that the coordinate of said point of measurement (12) should be specified by distributing proportionally the third side which connects the first pixel location (10) and the second pixel location (11).

[Claim 3] As a data format showing a curve (400) The die length of whenever [ azimuth / which shows the direction of the curve of curves, such as an include angle which two bowstrings in the bowstring (501) (502) (503) (504) of said curve (400) make, / (408), or curvature ], (409) (410), and (411) a bowstring (501) (502) (503) (504) The curvilinear discernment system according to claim 1 or 2 characterized by specifying to the configuration and direction of said curve (400), and carrying out storage, playback, or collating by said combined numerical group.

[Claim 4] one of the specific bowstrings (501) showing a curve (400) as a data format -- with a location measurement means to evaluate the location of the specific locus point (402) (403) (404) at one end (405) to location data The curvilinear discernment system according to claim 3 characterized by specifying to the configuration, direction, and location of said curve (400), and carrying out storage, playback, or collating by said numerical group including the location data.

[Claim 5] A block fragmentation means to subdivide in the block image divided into plurality, The 1st binarization processing means which strengthens the contrast of this block image, carries out binarization to black and white, and obtains a binarization processing image, A direction detection means of a crest to detect the protruding line pattern of a crest of said fingerprint, i.e., the direction, from this binarization processing image, Judge the image information of the line which met in the direction of said crest to be effective, and the image information which does not meet in the direction of said crest is judged to be a noise. A gray-scale image improvement means to remove the noise and to obtain an improvement image, The 2nd binarization processing means which strengthens the contrast of this improvement image, carries out binarization to black and white, and obtains a binarization processing image, A thinning means to change into the crest which carried out thinning of said crest which consists of two or more pixel width of face even to single pixel width of face by carrying out width-of-face compression toward the core of the pixel width of face, A false singular point amendment means by which said crest considers that the endpoint (21) close to the approaching endpoint (20) with the crest of this direction or the branch point or the endpoint (22) close to the frame of an image is the false singular point which was missing and occurred, and connects it in a noise, A curvilinear discernment system given in any 1 term of claim 1

characterized by having had a singular point extract means to have considered that the endpoint and the branch point of said crest after performing this false singular point amendment are the true singular point, and to extract them, and applying to fingerprint authentication thru/or claim 4.

[Claim 6] The point on other crests matched with a certain focus (91) is set to the secondary focus (92), (93), (94), and (95). It has a singular point extract means to add to the focus of a fingerprint by making into a singular point crest configuration the configuration (RS1) (RS2) (RS3) of the crest which makes the starting point the secondary focus (92), (93), (94), and (95) (RS4). A curvilinear discernment system given in any 1 term of claim 1 characterized by applying to fingerprint authentication thru/or claim 4.

[Claim 7] Said thinning means and the 1st endpoint extract processing in which make the column connection processing section, and nothing and its column connection processing section pass original monochrome image with said false singular point amendment means, and only said endpoint of the 1st classification is extracted, A POJINEGA reversal means to display in white the signal extracted by the 1st endpoint extract processing, By making the 2nd endpoint extract processing which extracts said endpoint of the 2nd classification in which the signal displayed in white is acquired by the 2nd time by passing said column connection processing section Nothing [ which can obtain both the endpoint in

the crest of said Hara monochrome image, and the branch point / the singular point extract means and nothing ], the curvilinear discernment system according to claim 5 characterized by applying to fingerprint authentication.

[Claim 8] As a means to identify the false focus of a fingerprint, and the true focus, about each three crest or valley line connected at the branch point (101) of a crest or a valley line The point (102) (103) on the crest separated from said branch point (101) at the equal distance or a valley line is searched for. The 2-dimensional coordinate of three points (102) (103) (104) when considering that said branch point (101) is a zero ( $X_a, Y_a$ ), Ask for ( $X_b, Y_b$ ) and it is set to two points (102) (103) of either of tripartite [ these ] (102) (103) (104). ( $X_c, Y_c$ ) the product ( $X_a-X_b$ ) of a horizontal component of the coordinate ( $X_a, Y_a$ ) of two points, and the product ( $Y_a-Y_b$ ) of a vertical component -- a guide peg, when larger than the threshold which has a value ( $X_a-X_b+Y_a-Y_b$ ) the bottom ( $X_b, Y_b$ ) By considering that this is the true branch point and considering that it is the false branch point when two points which take a bigger value than a threshold do not exist A curvilinear discernment system given in any 1 term of claim 1 characterized by having had the false branch point distinction means whose implementation of said purpose to identify is enabled by very small computational complexity, and applying to fingerprint authentication thru/or claim

[Claim 9] With the television cameras or the equivalent fingerprint image input means of photoing the fingerprint image inputted by the raster scan method, and those fingerprint image input means A signal-processing means to process the inputted fingerprint image in detail even in said numerical group immediately after reading said block image locally and in fragments in one frame, A curvilinear discernment system given in any 1 term of claim 1 characterized by having had a means to have repeated processing of a block image in which the fingerprint images in two or more frames differ, and to perform evaluation processing of the whole fingerprint image, and applying to fingerprint authentication thru/or claim 7.

[Claim 10] To the 2-dimensional space where two fingerprints were divided in the shape of a grid in a fingerprint authentication means to distinguish whether it is the same thing Each grid prepares the memory corresponding to a memory address which can be read [ write-in ]. A means to calculate the similarity index value which chooses as arbitration every one focus extracted from each two fingerprint, sends a large value when the similarity of the configuration of these two focus is high, and sends a value small when similarity is low, A series of actuation which writes the accumulation value which added the value of the horizontal component of the 2-dimensional vector which connects the two focus for this similarity index value, and a vertical component to the value stored in the

memory address corresponding to the grid of said explanation given a 2-dimensional coordinate in the again same memory address is repeated. The greatest thing is made into the synthetic similarity index value of these two fingerprints among the data values finally stored on memory. It is the curvilinear discernment system characterized by applying to fingerprint authentication judging with it being the same fingerprint when it is beyond a threshold with this synthetic similarity index value, judging with it being a fingerprint which is different if smaller than a threshold, and not needing gap amendment of the location about the parallel displacement of a fingerprint.

[Claim 11] In the curvilinear discernment system possessing the fingerprint authentication means which does not need the location gap amendment about a parallel displacement according to claim 10 Spin compensation of the coordinate of all the focus contained in one side of the two fingerprints to compare about amendment of the location gap about rotation is carried out a core [ a criteria zero ]. About those focus configurations The curvilinear discernment system which carries out spin compensation of the azimuth of the focus at the same include angle, and is characterized by enabling collating highly precise also to rotation of arbitration, and a gap of a parallel displacement.

[Claim 12] The curvilinear discernment system according to claim 9 characterized by having had the algorithm which reads one fingerprint image 6

thru/or less than [ of duration 25 minutes / 6 second ] for seven frames, and is completed to evaluation processing, and applying to fingerprint authentication.

[Claim 13] A curvilinear discernment system given in any 1 term of claim 1 which considers as the fingerprint description data which specified the configuration of said crest connected with said singular point by said numerical group, and is characterized by to have had a collating means collated with the collating sample or the built TETA base beforehand registered as an object for collating to the fingerprint description data, and to apply to fingerprint authentication thru/or claim 12.

[Claim 14] collection of said fragmentation, the improvement to said noise or amendment processing, said binarization, said thinning, and said fingerprint description data, and a series of data processing of collating -- the computer in which per second 100 million instruction execution is possible -- operating -- per fingerprint image -- necessary minimum -- a curvilinear discernment system given in any 1 term of claim 1 characterized by to have had said collating means which assigned 40 thru/or 60 bytes of said fingerprint description data, and to apply to fingerprint authentication thru/or claim 13.

[Claim 15] A curvilinear discernment system given in any 1 term of claim 1 characterized by having had an extract means to extract necessary minimum 40 thru/or said 60 bytes of fingerprint description data from said fingerprint image

inputted from the terminal machine, and a means to notify the result which connected these fingerprint description data to the communication network, and was collated with said database to said terminal machine, and applying to fingerprint authentication thru/or claim 14.

[Claim 16] him of medicine, social welfare, a service industry, administration, or a financial institution -- the terminal machine or the independent equipment which has which function of historical-data retrieval, locking, the various issue of banknotes, sale of tickets, a ticket gate, examination of tickets, police inspection, accounting, electronic commerce, and the asset-management employment -- combining -- arranging -- fingerprint authentication -- him -- a curvilinear discernment system given in any 1 term of claim 1 characterized by using it as a check means thru/or claim 15.

[Claim 17] the structure embedded at the object article of security itself as a part of function of the security of software, or the design data security of the manufacture commission LSI -- arranging -- fingerprint authentication -- him -- a curvilinear discernment system given in any 1 term of claim 1 characterized by using it as a check means thru/or claim 16.

[Claim 18] the fingerprint description data of two or more fingers to logical operation -- him -- a curvilinear discernment system given in any 1 term of claim 1 characterized by setting up the regulation of a check thru/or claim 17.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] The examination of tickets replaced with the locking equipment and the ticket which replace this invention with a key or a card from a criminal investigation, or a commuter pass, The cashless payment margin transaction replaced with a credit card, or a recitation number and seal, The electronic commerce replaced also with asset-management employment of the stock trade which was checking him in the voice of a telephone, him who can apply even to the guard business of exclusive duty depending on discernment by viewing the historical data of a medical clinical recording, social welfare, a service industry, or administration and others, for example, retrieval of a copy of a family register, the BADGE, and a face -- it is related with a curvilinear discernment system applicable to the fingerprint authentication system as a check means.

[0002]

[Description of the Prior Art] Without carrying out weighting to information value to the image of the whole fingerprint according to distinction of the location of whether to be easy to appear of the description, and the contents of an image, the database and the collating system consisted of curvilinear discernment systems applied by the conventional fingerprint authentication system etc. so that the whole fingerprint image might be collated with homogeneity with the naked eye.

[0003]

[Problem(s) to be Solved by the Invention] However, the approach which there are an image of the high part of the specific item, i.e., information value, which becomes curves, such as a fingerprint, in the local singular point and the crest configuration by which turbulence cannot be easily carried out to rotation, migration, and a noise, and an image of the part which is not so, needs to use them effectively in case it is collating, and is dealt with uniformly simply also had much futility. And in the data storage section for constituting the database used as the foundation of a collating system, when saving uniformly to the image data of a part with little information value, since memory space was wasted, it had become the factor of the cost rise of a collating system, and the speed limit of collating.

[0004] Moreover, in having advanced vainly collating which does not obtain a target with the raw data which are not extracted only at the main point also in case it collates, the effectiveness of collating was also bad, and it was difficult to obtain the high rate of collating. Furthermore, when the image data of a crest configuration was used for collating, without relating to the location of the singular point, and the singular point directly, in the case of fingerprint authentication, properly speaking, the information which shows relation with the singular point which should contribute to collating was not used, therefore rotation, migration, and collating degradation by the noise were remarkable in it.

[0005] This invention removes the fault of the curvilinear discernment system used for this conventional fingerprint authentication etc. Also in case do not waste memory space and it is collated, it extracts [ only at the main point ] and is efficient, and it is further related with the image data of a crest configuration. The description data which become only by the numerical information which shows physical relationship with the singular point are used effectively. Rotation, migration, and degradation of the collating precision by the noise are avoided, and it aims at offering cheaply the curvilinear discernment system which a quick result is obtained at the high rate of collating, and can apply a collating process to fingerprint authentication etc. a high speed and by making it go on correctly.

[0006]

[Means for Solving the Problem] In order to attain said purpose, invention concerning claim 1 It goes on to the end of said curve (40), following the extended direction of the curve (40) which starts at the singular point (30) as a data format showing a curve by the bowstring (41) of unit length, (42), (43), and (44), and attaching point of measurement (31), (32), (33), and (34) at a time one by one. [ with an unit length of 1 ] It was made to carry out storage of a curvilinear configuration, playback, or collating to the measurement means which carries out sequential measurement of the die length of the bowstring (51) by said singular point (30) and the point of measurement of said each point of measurement to 2 unit point, (52), and (53) by the numerical group of the measurement data.

[0007] If it is the curve which the direction of a curve does not reverse by having done in this way, the physical relationship of the one singular point (30) and four point of measurement (31), (32), (33), and (34) can be restored only from the numerical information of the die length and said unit length of three bowstrings (51), (52), and (53). And if it is the curve which the direction of a curve does not reverse by connecting the point of measurement on the original curve, taking the overlapping point of measurement into consideration when this actuation is repeated, the original curve can be restored or specified completely. And even if such how to express a curvilinear configuration moves or rotates the same curve,

the physical relationship of the die length of three bowstrings (51), (52), and (53), the one singular point (30) and four point of measurement (31), (32), (33), and (34) is eternal.

[0008] And a curve can be expressed with small memory space if it is this approach. Therefore, if it is the curve which the direction of a curve does not reverse, the length of a curve and a configuration can be correctly memorized, reproduced or collated only by the numerical group of measurement data. And even if it moves or rotates a sample, curved discernment can be performed convenient. That is, the data format showing this curve is how to express a curvilinear configuration strong against migration or rotation.

[0009] Generally, if it is the comparison of only a numerical group, the machine is more advantageous than people positively. Even if people can do these things, they transpose at a machine "the configuration pattern recognition of a thing" made comparatively difficult for a machine to abbreviation completeness, and in addition, they bring about a high speed and the effectiveness which can be processed correctly for a vast quantity of databases of more than forge fire.

[0010] Moreover, invention concerning claim 2 sets macroscopically the image which consists of two or more pixels which had predetermined spacing and were arranged regularly to the image-processing algorithm changed into said numerical group precisely and microscopically. When said point of measurement

exists in the location of said spacing, as a means to compute the coordinate of the point of measurement (12) on said curve which is in a regular slant range (99) from a certain reference point (100) on said curve. The triangle which connects the second pixel location (11) and said reference point (100) which exists in the distance from a regular slant range (99) from the first pixel location (10) and said reference point (100) which is in near from a regular slant range (99) from said reference point (100) is assumed. With a ratio with the die length of the first side which connects the first pixel location (10) to said reference point (100), and the second side which connects the second pixel location (11) to said reference point (100), and the slant range (99) of said convention. It had the point-of-measurement calculation algorithm which carries out an approximation calculation that said coordinate should be specified by distributing proportionally the third side which connects the first pixel location (10) and the second pixel location (11).

[0011] Since a count top can also presume strictly the point overlooked by the image pick-up side which cannot exist only with the resolution of finite existing in the clearance part of two or more pixels which have the visual performance arranged full of clearances when expanding and seeing by this, the resolution of infinity can be pursued theoretically.

[0012] moreover, invention concerning claim 3 as a data format showing a curve

(400) The die length of whenever [ azimuth / which shows the direction of the curve of curves, such as an include angle which two bowstrings in the bowstring (501) (502) (503) (504) of said curve (400) make, / (408), or curvature ], (409) (410), and (411) a bowstring (501) (502) (503) (504) It specifies to the configuration and direction of said curve (400), and was made to carry out storage, playback, or collating by said combined numerical group.

[0013] A configuration identifies specifying to the curve direction of the curve, even if it is the curve which the direction of a curve reverses to the shape of S character by having done in this way, the reappearance to a curve from a numeric value also becomes completely possible, and though it is the curve of the configuration which was alike also in the curve which rotated on the recognition screen further when numeric values other than the numeric value which shows a direction were in agreement, it becomes possible to identify those differences. Paradoxically, if the curve of a similar configuration is collated at a glance, it can conclude that that it is the same curvilinear configuration probably only rotated.

[0014] moreover, one of the specific bowstrings (501) as a data format with which invention concerning claim 4 expresses a curve (400) -- it specifies to the configuration, the direction, and the location of said curve (400), and storage, playback, or collating carry out to a location measurement means evaluate the

location of the specific locus point (402) (403) (404) at one end (405) to location data, by said numerical group including the location data. By having done in this way, it becomes possible to identify that by the difference in the numeric value which shows the location which the curve moved on the recognition screen.

Paradoxically, if the curve of a similar configuration is collated at a glance, it can conclude that that it is the same curvilinear configuration probably only moved.

[0015] Moreover, a block fragmentation means to subdivide invention concerning claim 5 in the block image divided into plurality, The 1st binarization processing means which strengthens the contrast of this block image, carries out binarization to black and white, and obtains a binarization processing image, A direction detection means of a crest to detect the protruding line pattern of a crest of said fingerprint, i.e., the direction, from this binarization processing image, A gray-scale image improvement means to judge the image information of the line which met in the direction of said crest to be effective, to judge the image information which does not meet in the direction of said crest to be a noise, to remove the noise, and to obtain an improvement image, The 2nd binarization processing means which strengthens the contrast of this improvement image, carries out binarization to black and white, and obtains a binarization processing image, A thinning means to change into the crest which carried out thinning of said crest which consists of two or more pixel width of face

even to single pixel width of face by carrying out width-of-face compression toward the core of the pixel width of face, A false singular point amendment means by which said crest considers that the endpoint (21) close to the approaching endpoint (20) with the crest of this direction or the branch point or the endpoint (22) close to the frame of an image is the false singular point which was missing and occurred, and connects it in a noise, It had a singular point extract means to have considered that the endpoint and the branch point of said crest after performing this false singular point amendment are the true singular point, and to extract them, and applied to fingerprint authentication. By having done in this way, fingerprint authentication is possible at the high rate of collating also to the input image of the fingerprint containing a noise.

[0016] Moreover, invention concerning claim 6 is a means which makes the focus of a fingerprint the crest configuration which makes the starting point the singular point which newly extracted the place which had what has the very few singular point of the endpoint and the branch point of a crest in the individual fingerprint, and had a limitation in applicability with the fingerprint authentication means only using the true singular point based on said true singular point. Then, it had a singular point extract means to add to the focus of a fingerprint by making into a singular point crest configuration the configuration (RS2) (RS3) (RS4) of the crest which sets to the secondary focus (93), (94), and (95) the

point on other crests matched with a certain focus (91), and makes the starting point the secondary focus (93), (94), and (95), and applied to fingerprint authentication. Therefore, it makes it possible to expand applicability sharply by setting up the secondary singular point which can specify the starting point from the true singular point, and adding the crest configuration which makes the point the starting point to fingerprint information. The fingerprint which was not able to be registered only in a singular point crest configuration is also registered about 100%, and, specifically, can be collated now.

[0017] Moreover, the 1st endpoint extract processing in which invention concerning claim 7 makes the column connection processing section, and nothing and its column connection processing section pass original monochrome image with said thinning means and said false singular point amendment means, and only said endpoint of the 1st classification is extracted, A POJINEGA reversal means to display in white the signal extracted by the 1st endpoint extract processing, By making the 2nd endpoint extract processing which extracts said endpoint of the 2nd classification in which the signal displayed in white is acquired by the 2nd time by passing said column connection processing section, it applied to nothing [ which can obtain both the endpoint in the crest of said Hara monochrome image, and the branch point / the singular point extract means and nothing ], and fingerprint authentication.

[0018] Since it simplifies to the extreme, and an image configuration is considered as the image configuration which becomes only by the set of the simple curve which carries out neither branching nor a crossover and carries out fingerprint authentication with the simplified image configuration with said crest which branches to two forks by having done in this way to tone-reversal processing, it becomes that it is the best for machine collating of the huge number of samples, and it becomes that a high speed and exact fingerprint authentication are possible by the simple facility carry out the amount of memory smaller than before as the start.

[0019] Moreover, by the image which caught the fingerprint, a crest or a valley line is divided by the noise generated by various factors, the false focus occurs by it in many cases, and invention concerning claim 8 aims at offering an efficient means to discriminate this false focus from the true focus.

[0020] then, as a means to identify the false focus of a fingerprint, and the true focus, about each three crest or valley line connected at the branch point (101) of a crest or a valley line The point (102) (103) on the crest separated from said branch point (101) at the equal distance or a valley line is searched for. The 2-dimensional coordinate of three points (102) (103) (104) when considering that said branch point (101) is a zero ( $X_a, Y_a$ ), Ask for ( $X_b, Y_b$ ) and it is set to two points (102) (103) of either of tripartite [ these ] (102) (103) (104). ( $X_c, Y_c$ ) the

product ( $X_a - X_b$ ) of the horizontal component of the coordinate ( $X_a, Y_a$ ) of two points, and ( $X_b$  and  $Y_b$ ), and the product ( $Y_a - Y_b$ ) of a vertical component -- a guide peg, when larger than the threshold which has a value ( $X_a - X_b + Y_a - Y_b$ ) the bottom By considering that this is the true branch point and considering that it is the false branch point when two points which take a bigger value than a threshold do not exist, it had the false branch point distinction means whose implementation of said purpose to identify is enabled by very small computational complexity, and applied to fingerprint authentication. By having done in this way, it became possible to distinguish the false focus generated by the noise from the singular point true in small computational complexity and a high precision.

[0021] Invention concerning claim 9 with moreover, the television cameras or the equivalent fingerprint image input means of photoing the fingerprint image inputted by the raster scan method, and those fingerprint image input means A signal-processing means to process the inputted fingerprint image in detail even in said numerical group immediately after reading said block image locally and in fragments in one frame, It had a means to have repeated processing of a block image in which the fingerprint images in two or more frames differ, and to perform evaluation processing of the whole fingerprint image, and applied to fingerprint authentication.

[0022] A system configuration can be carried out in small memory space, without accumulating the raw image data of the whole fingerprint image which was wasting memory space by having done in this way, i.e., the image information before making amount-of-information reduction processing.

[0023] in short, there is the amount of information of the fingerprint image of one sheet, and since it wastes memory space, if it boils in detail the processing which simplifies and evaluates an image configuration to the extreme and performs it for every block part of the block image of a fingerprint along with the purpose of fingerprint authentication, the memory space which stores useless information is also unnecessary [ amount of information ]. [ too much ]

[0024] And even if said raster scan advances by said time amount which processing takes in detail, if a fingerprint image is skipped while processing, it will end. And the overview of a fingerprint is obtained when the block part of a block image required for fingerprint authentication waits for and reads the opportunity of the raster scan in the following frame.

[0025] In addition, in this system, even if the overview of a fingerprint is not necessarily obtained, fingerprint authentication can be carried out. Moreover, said this method that reads said block image locally and in fragments is effective just because it is it.

[0026] Moreover, in a fingerprint authentication means by which two fingerprints

distinguish whether it is the same thing, invention concerning claim 10 aims at making the computational complexity mitigate, although huge computational complexity was needed in order for there to be a means to calculate the similarity index value of each focus of each fingerprint, and to obtain the similarity index of a synthetic fingerprint and to amend the location gap also accompanied by rotation of a fingerprint. That is, it is the purpose about offering the means which eliminates the need for gap amendment of a parallel displacement among amendments of this location gap, and makes very high-speed fingerprint authentication realizable.

[0027] Then, it sets for a fingerprint authentication means by which two fingerprints distinguish whether it is the same thing. Each grid prepares the memory corresponding to a memory address which can be read [ write-in ] for the 2-dimensional space divided in the shape of a grid. A means to calculate the similarity index value which chooses as arbitration every one focus extracted from each two fingerprint, sends a large value when the similarity of the configuration of these two focus is high, and sends a value small when similarity is low, A series of actuation which writes the accumulation value which added the value of the horizontal component of the 2-dimensional vector which connects the two focus for this similarity index value, and a vertical component to the value stored in the memory address corresponding to the grid of said

explanation given a 2-dimensional coordinate in the again same memory address is repeated. The greatest thing is made into the synthetic similarity index value of these two fingerprints among the data values finally stored on memory. When it was beyond a threshold with this synthetic similarity index value, it judged with it being the same fingerprint, and it judged with it being a fingerprint which is different if smaller than a threshold, and applied not needing gap amendment of the location about the parallel displacement of a fingerprint to fingerprint authentication.

[0028] Moreover, invention concerning claim 11 is the same purpose as claim 10, eliminates the need for rotational gap amendment among amendments of said location gap, and aims at offering the means which makes very high-speed fingerprint authentication realizable.

[0029] Then, it sets to the curvilinear discernment system possessing the fingerprint authentication means which does not need the location gap amendment about a parallel displacement according to claim 10. Spin compensation of the coordinate of all the focus contained in one side of the two fingerprints to compare about amendment of the location gap about rotation is carried out a core [ a criteria zero ]. About those focus configurations [0030] which carried out spin compensation of the azimuth of the focus at the same include angle, and enabled collating highly precise also to rotation of arbitration,

and a gap of a parallel displacement Moreover, invention concerning claim 12 was equipped with the algorithm which reads one fingerprint image 6 thru/or less than [ of duration 25 minutes / 6 second ] for seven frames, and is completed to evaluation processing, and applied it to fingerprint authentication. By having done in this way, the simplification of a facility was realizable, maintaining practicality.

[0031] Because, if the overview of a fingerprint is obtained by six in the television photography which continues and picturizes per second 25 frames or 30 frames, for example, one fingerprint image is read by the duration for  $6/25$  second or  $6/30$  second, and it completes to evaluation processing. This means system-wide simplification and a system-wide cost cut can be aimed at rather than holding a fingerprint image by one sheet and processing it by photography data, such as a digital camera with much [ unexpectedly ] amount of information.

[0032] Moreover, invention concerning claim 13 considers as the fingerprint description data which specified the configuration of said crest connected with said singular point by said numerical group. Since it had a collating means to collate with the collating sample or the built TETA base beforehand registered as an object for collating to the fingerprint description data and applied to fingerprint authentication a collating rate and the rate of collating can be raised by small memory space, as practical use level, rather than the conventional thing, it is

markedly alike and a high speed and exact collating can be performed.

[0033] moreover, collection of said fragmentation, an improvement of as opposed to said noise in invention concerning claim 14 or amendment processing, said binarization, said thinning, and said fingerprint description data and a series of data processing of collating -- the computer in which per second 100 million instruction execution is possible -- operating -- per fingerprint image -- necessary minimum -- since it had said collating means which assigned 40 thru/or 60 bytes of said fingerprint description data and applied to fingerprint authentication, reduction of still larger memory areas and collating at a high speed can perform.

[0034] Moreover, invention concerning claim 15 is equipped with an extract means to extract necessary minimum 40 thru/or said 60 bytes of fingerprint description data from said fingerprint image inputted from the terminal machine, and a means to notify the result which connected these fingerprint description data to the communication network, and was collated with said database to said terminal machine, and since it applied to fingerprint authentication, it can also perform use in a remote place.

[0035] Historical data retrieval moreover, invention concerning claim 16 -- him of medicine, social welfare, a service industry, administration, or a financial institution -- the terminal machine or the independent equipment which has

which function of locking, the various issue of banknotes, sale of tickets, a ticket gate, examination of tickets, police inspection, accounting, electronic commerce, and the asset-management employment -- combining -- arranging -- fingerprint authentication -- him, since it was made to use it as a check means him who had distinguished conventionally in a card, a key, a ticket, a commuter pass, a signature, seal, the BADGE, a face, and his voice -- it is made to require only momentary fingerprint authentication about a check

[0036] moreover, the structure which embeds invention concerning claim 17 at the object article of security itself as a part of function of the security of software, or the design data security of the manufacture commission LSI -- arranging -- fingerprint authentication -- him -- since it was made to use it as a check means, it becomes the cost reduction of security management.

[0037] moreover, invention concerning claim 18 -- the fingerprint description data of two or more fingers -- the logical operation of the fingerprint description data of two or more fingers -- him -- the regulation of a check was set up. By having done in this way, two or more men can be suitably set up free as a rightful claimant's tolerance with family limitation etc. For example, it can use for the automobile operation locking equipment which suits special agreement matters, such as family limitation in an automobile accident liability insurance. By that of 20 \*\*\*\*\*\*, the combination which becomes by the series count is rich in variety

from a recitation number, and, moreover, the protective effect for protection is strengthened with one person greatest.

[0038]

[Embodiment of the Invention] Hereafter, along with a drawing, one gestalt of operation by this invention is explained. Drawing 1 is the explanatory view of evaluation of the description bowstring in which one gestalt of operation of this invention is shown. In drawing 1, the crest 40 which consists of the singular point 30 by the smooth curve is prolonged. Here, the arc which the curve direction does not reverse in the shape of S character is assumed. It goes on to the end of said crest 40, following the extended direction of the crest 40 with the bowstrings 41, 42, 43, and 44 of unit length, and attaching 1 unit length (it also being hereafter called "point of measurement") of sampling points 31, 32, 33, and 34 at a time one by one. This is the point which measures the distance of the curvilinear section in a map with a divider. And based on the definition of said description bowstring, the die length of the base 51 of the isosceles triangle which connected 31 and 32 in a straight line to three points, 30 [ i.e., ], which continue from the singular point 30 to the sampling point 32 of two-point beyond is extracted as a description bowstring.

[0039] According to the explanation which is not caught by said isosceles triangle, advancing one unit of point of measurement at a time one by one with

31, 32, and 33 from the singular point 30 A measurement means to measure the die length of each bowstring by the point of measurement 33, 34, and 35 of 2 unit point from those point of measurement, respectively, That is, sequential measurement of the die length 51 of the bowstring from the singular point 30 to the 2nd point of measurement 32, the die length 52 of the bowstring from the 1st point of measurement 31 to the 3rd point of measurement 33, and the die length 53 of the bowstring from the 2nd point of measurement 32 to the 4th point of measurement 34 is carried out. Consider as the information which shows the curvilinear configuration of a crest 40 with the numerical group data which become by these measurement results 51, 52, and 53, and let the simple numerical group data be the fingerprint description data. He collates a fingerprint and is trying to raise a collating rate and the rate of collating by small memory space by comparing the fingerprint description data with the contents of the database built beforehand.

[0040] Next, drawing 2 is drawing which the curve 40 which should be identified moved and rotated. Here, if a curve 40 carries out [ aforementioned ] evaluation and is recognized, even if the curve 40 moves or is reversed, the die length of bowstrings 51, 52, and 53 will not change. Therefore, the configuration of a curve 40 can be recognized, saved, reproduced and identified with the numeric data which becomes by the die length of these bowstrings 51, 52, and 53, and

as projected on the mirror even if, even if it is upside-down, if numeric data is in agreement, it can collate.

[0041] Next, drawing 3 is the explanatory view of the principle which carries out the approximation calculation of the coordinate value of the point of measurement which exists in the clearance part of a pixel. In the image pick-up side of image sensors, such as a digital camera and a video movie, the pixel which becomes in the minute partition which reacts to light like people's naked eye retina occupies a predetermined number and area precisely, and is put in order. However, macroscopically, even if said pixel is precise, it is microscopically arranged by regular and finite with predetermined spacing.

[0042] By the way, in the case of the digital image processed by computer etc., the data of a screen are expressed by the data of only the point on the pixel arranged in a grid pattern as shown in drawing 3. The pixel to which the pattern was attached in these pixels presupposes that it is a pixel showing a curve. Therefore, a certain pixel 100 to the point 12 presumed to be on the curve for die length of 4 pixels is not necessarily an actual pixel. Then, it is necessary to calculate the point of measurement 12 on the curve which the distance of the die length for 4 pixels left from the information about the locations 10 and 11 of two pixels on the curve near the die length for 4 pixels. For example, the location of the point of measurement of this \*\* is calculable with the straight-line

approximation based on simple proportional distribution. Thus, the die length of the bowstrings 51, 52, and 53 shown in drawing 1 can be found from point of measurement 12 which is different in the locations 10 and 11 of a pixel.

[0043] Here, when said point of measurement 12 exists in the location of said spacing, it has the point-of-measurement calculation algorithm as a means to compute the coordinate of the point of measurement 12 on the curve 40 which is in the regular slant range 99 from a certain reference point 100 on a curve 40. And if a count top can also presume strictly points which will be overlooked by existing in the clearance part of two or more pixels which have the visual performance arranged full of clearances if it expands and sees, such as an image pick-up side which cannot exist only with the resolution of finite, the resolution of infinity can be pursued theoretically.

[0044] Here, the triangle which connects the second pixel location 11 and reference point 100 which exists in the distance from a slant range 99 is assumed from the first pixel location 10 and reference point 100 which is in near from a slant range 99 from a reference point 100. And the segment which connects the second side, the first pixel location 10, and the second pixel location 11 for the segment which connects the second pixel location 11 for the segment which connects the first pixel location to a reference point 100 to the first side and a reference point 100 is called the third side, respectively, and an

approximation calculation is carried out that said coordinate should be specified by distributing said third side proportionally with a ratio with the die length of the first side and the second side, and a slant range 99. by the precision situation of this approximation calculation, it is markedly alike and curvilinear discernment capacity improves.

[0045] Drawing 4 is the explanatory view of the curvilinear configuration system which used the azimuth and curvature of the focus. At the branch point 401 when the crest 400 shown in drawing 4 has branched, the crest 400 extended to the opposite direction of branching is considered. Branch point 401 self is first made into the first locus point, and the point on the crest 400 which only a certain distance D separated from this first locus point is made into the second locus point 402. Furthermore, the point on the crest 400 which only distance D similarly separated from the second locus point 402 is made into the third locus point 403. The fourth locus point 404 and the fifth locus point 405 are searched for by the same actuation. The locus points 401-405 here can be increased to arbitration until a crest 400 breaks off on the way. Next, by connecting these locus points 401-405 with a line segment 501-504, i.e., bowstrings, one by one, it is a line segment with the same die-length D, i.e., the thing which bowstrings 501-504 connected, and the curvilinear configuration of a crest 400 is approximated.

[0046] The approach of expressing efficiently the curvilinear configuration of the crest 400 approximated by this line segment 501-504, i.e., bowstrings The straight line which the line segment which connects the branch point 401 and the second locus point 402 first calculates the normal coordinate shaft 407 and the include angle (this is henceforth called the "azimuth" of the focus) to make, and then connects the branch point 401 and the second locus point 402, The straight line which calculates the include angle 409 which the straight line which connects the second locus point 402 and the third locus point 403 makes (this is henceforth called whenever [ of the focus / "whenever / curvature / of \*\* a first /" ]), and connects the second locus point 402 and the third locus point 403 further, It asks for the include angle which two line segments which adjoin like 410 and the following make one by one whenever [ include-angle / which the straight line which connects the third locus point 403 and the fourth locus point 404 makes /, i.e., curvature of \*\* second, ]. Information required here in order to express the curvilinear configuration of a crest is only 409,410,411 whenever [ curvature / of the second and \*\* a third ] for a start which are two or more line segments which adjoin the azimuth 408 of the focus, i.e., the include angle which a bowstring 501,502,503,504 makes.

[0047] it is expectable by considering information of 409-411 as the expression approach of the curvilinear configuration about the crest containing the focus

whenever [ azimuth / of these focus 401, i.e., the branch point, and the locus points 402-405 / 408, and curvature ], and performing fingerprint authentication based on this expression that the discernment capacity of a different fingerprint is markedly alike, and improves. In addition, the expression approach of this curvilinear configuration is applicable also as well as the focus which consists of an endpoint (refer to drawing 7 ) which the crest other than the focus to which the crest shown by drawing 4 has branched has severed.

[0048] Drawing 5 is a true singular point extract algorithm by thinning and POJINEGA reversal. The column connection processing section, and nothing and its column connection processing section are made to pass original monochrome image by false singular point amendment (step S8) with thinning (step S7). Moreover, by making width of face 1 pixel only taking advantage of the closing line of the longitudinal direction of a black side object (border-line enclosure of a bundle) among said Hara monochrome images, the algorithm which changes a field into a line is shown as thinning (step S7), and said black side object is simplified only to a segment. In addition, the situation of concrete thinning (step S7) is later mentioned along with drawing 8 .

[0049] And the 1st endpoint extract processing in which only said endpoint of the 1st classification is extracted, The POJINEGA reversal which displays in white the signal extracted by the 1st endpoint extract processing (step S70), The

signal displayed in white only two convenience by checking having passed said column connection processing section according to the count check of processing (step S72), and making the 2nd endpoint extract processing which extracts said endpoint of the 2nd classification in which it is obtained It enables it to apply to nothing [ which can obtain both the endpoint in the crest of said Hara monochrome image, and the branch point / the singular point extract means and nothing ], and fingerprint authentication. Drawing 8 explains this in detail like after.

[0050] Since it simplifies to the extreme, and an image configuration is considered as the image configuration which becomes only by the set of the simple curve which carries out neither branching nor a crossover and carries out fingerprint authentication with the simplified image configuration with said crest which branches to two forks by having done in this way to tone-reversal processing, it becomes that it is the best for machine collating of the huge number of samples, and it becomes that a high speed and exact fingerprint authentication are possible by the simple facility carry out the amount of memory smaller than before as the start.

[0051] Drawing 6 is the true singular point extract algorithm included to the gray-scale image improvement means. 1st binarization processing (step S3) which strengthens the contrast of the block image which was divided into

plurality by the block fragmentation means and was subdivided, carries out binarization to black and white, and obtains a binarization processing image is performed, and the direction detection of a crest (step S4) which detects the protruding line pattern of a crest of said fingerprint, i.e., the direction, from the binarization processing image is performed.

[0052] And by the direction detection of a crest (step S4), the direction of a crest is searched for and it uses as auxiliary information at the time of removing a noise component. That is, the image information of the line which met in the direction of said crest is judged to be effective, the image information which does not meet in the direction of said crest is judged to be a noise, and it results in the gray-scale image improvement (step S5) which removes the noise and obtains an improvement image. In addition, although binarization is a stock-in-trade which digitizes the analog electrical signal which becomes with an ambiguous mean value, it is a means to transform into a 1-bit digital electrical signal the digital electrical signal expressed with two or more bits, such as 8 etc. bits, and is based on the size comparison actuation between a certain reference values here.

[0053] here -- drawing 7 -- the explanatory view of the false singular point -- it is -- (a) -- it is the explanatory view of the endpoint (20) which approaches with the crest of the same direction.

(b) It is the explanatory view of the endpoint (21) close to the branch point.

(c) It is the explanatory view of the endpoint (22) close to the frame of an image.

pass the false singular point amendment (step S8) which amends a noise component from said fingerprint data -- it results in a true singular point extract (step S9). The concrete means of this false singular point amendment (step S8) is postprocessing, and is explained along with drawing 7. Drawing 7 (a), (b), and (c) are wrong with a noise component etc., and are caught. It is the explanatory view of three kinds of false singular points taken for it being the singular point in spite of not being the singular point. The amendment regulation with which a crest considers that the endpoint close to the frame or the branch point of an image or the endpoint which approaches with the crest of this direction is the false singular point which was missing and occurred, and connects it in a noise is applied to false singular point amendment (step S8) as said postprocessing.

[0054] And perform 2nd binarization processing (step S6) which returns explanation to drawing 6, strengthens the contrast of said improvement image again, carries out binarization to black and white, and obtains a binarization processing image, and it sets in the binarization processing image. Thinning (step S7) which changes said crest which consists of two or more pixel width of face, i.e., a crest with a certain width of face, into the crest which carried out thinning even to single pixel width of face by carrying out width-of-face

compression toward the core of the pixel width of face is performed. Thinning (step S7) simplifies the image of a complicated configuration more, is fitted to evaluation and machine computation, and has the operation which makes collating simple.

[0055] Next, false singular point amendment (step S8) which considers that the endpoint 21 close to the approaching endpoint 20 with the crest of this direction or the branch point or the endpoint 22 close to the frame of an image is the false singular point which said crest was missing and occurred, and connects it in a noise is performed. As mentioned above, in drawing 6, it had a singular point (step S9) extract means by which considered that the endpoint and the branch point of said crest after giving to false singular point amendment are the true singular point, and a series of image processings to an input image extracted them, and applied to fingerprint authentication. By having done in this way, fingerprint authentication is possible at the high rate of collating also to the input image of the fingerprint containing a noise.

[0056] And drawing 8 is the explanatory view of the singular point extraction method by tone reversal and thinning, and, for (a), the explanatory view of monochrome block image before processing and (b) are [ the explanatory view of a tone reversal block image and (d of the explanatory view of the extract singular point of halfway processing and (c)) ] the explanatory views of the

extract singular point after a final treatment. if it becomes the image processing of (b) from (a) in drawing 8 by thinning (step S7), and it compares before processing at least this, although it is a true singular point extract algorithm by thinning (step S7) and POJINEGA reversal (step S70) which were already explained along with drawing 5, and it will be markedly alike and amount of information will be reduced -- two forks -- a burden remains in evaluation of the branch point. In drawing 8 (b), it becomes the neck of not making a meaning judgment to \*\* (a) in case [ which is amount of information fairly ] it is fingerprint authentication since it has the branch point, although it has mitigated.

[0057] then, said two forks -- the image processing of (c) to (d) -- becoming -- said two forks -- a junction is expressed with the end of a finite curve, i.e., the singular point. [ in / further / the image processing of (c) is performed from (a) in drawing 8 by POJINEGA reversal (step S70) so that a junction may be lost, and / by thinning (step S7) / drawing 8 ] And it puts into practice by repeating these processings twice. Thus, if the singular point after a finite curve without the branch point and a final treatment is extracted, by losing the branch point, amount of information will be reduced further, and evaluation is also easy, and there will be little amount of information of the evaluation information absolutely compared with image-processing before, and it will end. And since fingerprint authentication results in an unique decision matter and it becomes artificially

unnecessary judging it covering many items, it comes to be suitable for machine processing, and processing accelerates, and there is also little memory space, it ends, and, also in construction and its maintenance of a database, a burden becomes light.

[0058] Drawing 9 is the explanatory view of the curvilinear discernment system using the secondary focus. The crest directional axis Y1 connected to the focus 91 when its attention is paid to a certain focus 91, as shown in drawing 9, It is on the axis of coordinates of the perpendicular shaft X1, and extracts from the focus 91 using the equidistant expression approach of the curvilinear configuration which considered that four 92, 93, 94, and 95 were the secondary focus, and described above the configurations RS1, RS2, RS3, and RS4 of the crest by the side of recently [ of these secondary focus ] along with drawing 4. it is expectable that these four secondary focus crest configurations RS1, RS2, RS3, and RS4 boil that collating precision markedly, and raise it by catching in fragments the pattern of the whole fingerprint seen from the focus 91 of a basis, and using this additional information for fingerprint authentication. Therefore, it makes it possible to expand applicability sharply by setting up the secondary singular point which can specify the starting point from the true singular point, and adding the crest configuration which makes the point the starting point to fingerprint information. The fingerprint which was not able to be registered only

in a singular point crest configuration is also registered about 100%, and, specifically, can be collated now.

[0059] Drawing 10 is an explanatory view about the judgment using an inner product of removal of the false singular point. As shown in drawing 10, that in which the branch point of a true crest has the configuration which is divided into the field A101 surrounded at one narrow include angle centering on the branch point and the fields A102 and A103 surrounded at two large include angles is almost the case. Moreover, as shown in drawing 8, the endpoint of a true crest can be regarded as the branch point of a valley line, and has a property with a configuration which is divided into the field A101 surrounded at one narrow include angle, and the fields A102 and A103 surrounded at two large include angles like the branch point of the aforementioned crest in that case. These properties are used, the point 102,103,104 on the crest which separated the field which the branch point of such a crest or a valley line is dividing from the branch point 101 at the equal distance as shown in drawing 10 in order to distinguish by small computational complexity, or a valley line is searched for, and the 2-dimensional coordinate (Xa, Ya) of three points when considering that the branch point is a zero is searched for (Xc, Yc). (Xb, Yb)

[0060] and the pair of a point 102 and a point 103 -- setting -- the product (Xa-Xb) of the horizontal component of a coordinate, and the product (Ya-Yb) of

a vertical component -- a guide peg -- a value ( $X_a - X_b + Y_a - Y_b$ ) is calculated the bottom (the value which can be found by this actuation is henceforth called "the inner product value of two points"). If that value is large, and that value of these two line segments is conversely [ nothing and ] small in a narrow include angle, it will have [ since this inner product value of two points is proportional to the cosine of the include angle which the straight line which connected the straight line and the branch point 101 which connected the branch point 101 and a point 102, and a point 103 makes, ] a large include angle. Similarly, it asks by actuation with the same said of the inner product value in a point 103 and a point 104, and the inner product value in a point 104 and a point 102. Dividing into the field where this branch point was surrounded at one narrow include angle explained above when there was what [ a ] is larger than a certain threshold among these three inner product values exactly, and the field surrounded at two large include angles is shown, it judges that it is the true branch point, and, in other than this, it is judged that this branch point is the false branch point.

[0061] The focus needed to be compared, after specifying the gap of this location and a direction and performing suitable location gap amendment, when performing fingerprint authentication although the location and direction of the focus changed with the location and include angle which place a finger even if it compared about some two fingerprint images and these fingerprints were the

things of the same finger. Thus, in order to specify a gap of a location and a direction and to perform suitable location gap amendment, the big limit had joined the gap of a location and the gap of an include angle which it is presupposed that huge computational complexity is required conventionally, therefore can be permitted.

[0062] The approach of the fingerprint authentication which does not need the location gap amendment for below about a gap of a parallel displacement is explained. First, as shown in drawing 11, 2-dimensional space with the breadth of the rectangle of a certain magnitude is divided in the shape of a grid, and each grid prepares the memory with the room of the 2-dimensional structure corresponding to a memory address which can be read [ write-in ]. Drawing 11 shows the room of the two-dimensional-array structure which consists of a train of M lines and N individuals. At the time of initiation of fingerprint authentication processing, the initial value (for example, zero value) decided beforehand is stored in each memory address of this memory.

[0063] Next, those configurations evaluate the similarity index value which is similar, about the pair of the focus which it chose one [ at a time ] from two fingerprints, respectively. Based on the similarity of the direction of a crest in the focus, or its curvilinear configuration, when similarity is high, a function with the property which outputs a value (for example, 1) small when similarity is low for a

large value (for example, 259) is used for the performance index which calculates this similarity index value.

[0064] And the 2-dimensional vector ( $X_b-X_a$ ,  $Y_b-Y_a$ ) which connects even the 2-dimensional coordinate value ( $X_b$ ,  $Y_b$ ) of the focus which belongs to the fingerprint of another side about the two aforementioned focus from the 2-dimensional coordinate value ( $X_a$ ,  $Y_a$ ) of the focus belonging to one fingerprint is searched for. Horizontally ( $X_b-X_a$ ), when the former fingerprint carries out the parallel displacement only of the ( $Y_b-Y_a$ ) perpendicularly, as for this, it means being located on the 2-dimensional coordinate with these two same focus exactly to it. When it has a value with the high similarity index value between these two focus, it is shown that possibility that a gap of the actual parallel translation of a fingerprint is said 2-dimensional vector ( $X_b-X_a$ ,  $Y_b-Y_a$ ) is high, and when a similarity index value is conversely low, it is shown that possibility that gaps of the parallel translation of an actual fingerprint are ( $X_b-X_a$  and  $Y_b-Y_a$ ) is low.

[0065] Next, when it considers that the aforementioned 2-dimensional vector ( $X_b-X_a$ ,  $Y_b-Y_a$ ) is a 2-dimensional coordinate value, This coordinate value investigates in which grid on the 2-dimensional space shown in drawing 11 it is contained, reads from memory the value stored in the memory address corresponding to the grid containing this, and writes the accumulation value

which added the similarity index value between the two focus to that value in the again same memory address.

[0066] Drawing 11 is the explanatory view of the storing memory area of the accumulation value of the similarity index value in the collating approach which does not need the gap amendment about a parallel displacement. Count of the similarity index value of the focus pair in said explanation, count of the 2-dimensional vector between the two focus, The grid of drawing 11 in which the coordinate value is contained when it considers that a 2-dimensional vector is a 2-dimensional coordinate value is specified. Write the accumulation value which added the similarity index value to the values 1-259 (it is not a sign) stored in the memory address corresponding to the grid in the same memory address. A series of actuation to say is repeated about a pair of part or all combination of the focus chosen one [ at a time ] from two fingerprints, respectively. Then, let the greatest thing (for example, 259) be the synthetic similarity index value of these two fingerprints among the accumulation values of the similarity index value stored in each memory address. When larger than a threshold with this synthetic similarity index value, it judges with it being the same fingerprint. Since the gap amendment about the parallel displacement of arbitration is processed by coincidence by this approach, fingerprint authentication with very little computational complexity is realizable.

[0067] Although the approach of the fingerprint authentication which the gap amendment about a parallel displacement does not need was explained until now, by performing gap amendment about rotation explains how to enable highly precise collating also to rotation of arbitration, and a gap of a parallel displacement here. The gap amendment about an certain angle of rotation performs spin compensation of the include angle to one focus of all among two fingerprints to collate. Although focus data consist of the 2-dimensional coordinate value and its focus configuration information on the focus as explanation of the above, about the 2-dimensional coordinate value of the focus, they perform amendment by rotational transform centering on a criteria zero, and amend [ information / focus configuration ] the same include angle to a focus azimuth. In addition, about the information expressing the curvature of a focus configuration, since it is eternal also about a rotation, amendment is not needed. Thus, after performing the aforementioned spin compensation to all the focus of one fingerprint, it collates by fingerprint authentication without the need for the location gap amendment about the parallel displacement of said explanation.

[0068] Drawing 12 is the singular point extract algorithm of a raster scan and the recognition processing by evaluation of a full screen. Partial block data is saved locally, without scanning the screen of one frame in time amount, for example, 1/25 second, or 1/30 predetermined second, recognizing each pixel and each

block data by predetermined sequence, and accumulating all the image information of one frame, since a television camera image input (step S1) is based on the television method of a well-known raster scan (step S92).

Henceforth, it carries out in a short time to which the singular point extract processing (step S93) shown by drawing 5 and drawing 6 was restricted.

[0069] however, local [ image / of one sheet / fingerprint ] in singular point extract processing (step S93) and singular point data storage (step S94) noting that the computer in which per second 100 million instruction execution is possible operates for singular point extract processing (step S93) and said fingerprint description data around 50 bytes per fingerprint image are assigned -- every -- about about 1/5 second is taken to finish carrying out sequential execution. In addition, although it is 0.24 seconds in fact [ about about 1/5 second ], a fraction indication of the explanation is given for convenience, and it is the time amount taken said to scan 6/25 frame or 6/30 thru/or seven frames. Therefore, if 5 or 6 thru/or 7 frames carry out a raster scan, since it is equivalent to said about 1/5 second, said whole fingerprint image of one sheet is covered, singular point extract processing (step S93) and singular point data storage (step S94) are completed, and the check (step S95) of full-screen processing is judged to be completion, and serves as completion of recognition processing of one fingerprint image.

[0070] And drawing 13 is the algorithm of the fingerprint authentication system shown as 1 operation gestalt of this invention. The algorithm to a television camera image input (step S1) thru/or a true singular point extract (step S9), and the check (step S95) of full-screen processing already connects the contents [ finishing / abbreviation explanation ] along with drawing 5 , drawing 6 , and drawing 9 .

[0071] Moreover, the block fragmentation (step S2) immediately after a television camera image input (step S1) makes the block image which are indispensable requirements, and was divided and subdivided by plurality result with this operation gestalt to binarization processing (step S3) and a gray-scale image improvement (step S5). Moreover, if the result of a check (step S95) of full-screen processing is "yes", it results in storing (step S75) in collating processing (step S74) or a fingerprint authentication database. In addition, in the case of collating processing (step S74), comparison collating is carried out with the collating sample data of a fingerprint authentication database in the state of the evaluated data.

[0072] In addition, even if it does so, required information is made to overlap mutually between adjoining blocks so that it can secure or supplement with the information for a full screen, without being missing although software removes the noise to the knot of said block image by that (not shown) which a noise in a

grid pattern generates.

[0073] Thus, the computer which executes 100 million instructions in 1 second performs a series of actuation of the noise rejection of the inputted fingerprint image, an image improvement, binarization, thinning, false singular point removal, and collating with a database in 0.24 seconds, and processes said fingerprint description data to one fingerprint image identifiable by 40 thru/or 60 bytes of amount of data.

[0074] Moreover, an image quality improvement and various processings are explained further. As shown in drawing 6 and drawing 13, from the fingerprint image before carrying out image division, the direction detection of a crest (step S4) extracted the information on the direction of a crest, the directivity filter which is not illustrated was controlled, and it uses for said gray-scale image improvement (step S5). A fingerprint image is inputted into a directivity filter, information correction is made here so that the line which traced that in the configuration appropriate for a fingerprint in accordance with the information on said direction of a crest may be added, if there is a part which requires correction to the extent that this deviates clearly from the configuration of a general fingerprint, and it improves in a clearer image. It is carrying out by the program of a digital signal processor (it is also hereafter called DSP) so that the correction which is equal to discovering an important point correction part with people's

naked eye, guessing from [ of the perimeter ] a crest in short, and adding manual correction may be automatically made by software.

[0075] Moreover, if block fragmentation classifies the television screen of a raster scan method in a grid pattern and it carries out data processing for every block image, it will simplify processing of unskillful complicated image information to a machine, and will be brought close to meaning processing. It is because it will be simplified, the crest configuration will become the line drawing which can be simply expressed in writing only by relation with the singular point and recognition by meaning processing with a machine will also become possible, if one fingerprint image is expanded.

[0076] Therefore, composition of the one fingerprint image is carried out to a close-up on a television screen, and if it is divided into each block image, it will be brought close to meaning processing. However, do not make all of the information on said each block image memorize, and it contributes to fingerprint authentication. Until each time immediately after reading said each block image for rotation, migration, and the extract of the description bowstrings 51, 52, and 53 which coil round the local singular point 30 and local it strong against a noise, carrying out local conclusion data processing While spending the processing time, the information on the block image corresponding to the image reading section (not shown) which the raster scan progressed and moved is skipped. It

does not read, while thinking in short. By doing so, required memory space can be stopped few. It is the system configuration which specifically connected with the small television camera the digital signal processor (DSP) which is not illustrated. The program of DSP is equipped with the algorithm of this invention in the form of a program.

[0077] 200x200 incorporated by the raster scan method from said small television camera = the temporary storage of the front screen which becomes by more than 20,000 pixels is carried out to the data memory of DSP for every 32x22-pixel small block image, and it sets up along with a crest 40, sampling point of measurement 31, 32, 33, and 34 immediately, and evaluates to singular point crest information, i.e., the fingerprint description data. Thus, it is evaluated and the extracted fingerprint description data are stored in the data memory which is not illustrated.

[0078] And processing same about the data of the small block image inputted into a degree is performed. Moreover, since time amount is taken for said DSP to extract the description bowstrings 51, 52, and 53, processing of the continuous block cannot be performed. That is, while a computer thinks, it is busy with evaluating singular point crest information, and as new information is not read, saving of memory space is aimed at in the meantime.

[0079] Since processing of said small block image can be performed

independently, it is the scan of the speed of per second 25 frames (PAL or SECAM system television of Europe and Russia), for example, and he inputs the fingerprint image of six frames and is trying to cover all image fields as a whole in this system. Conversely, if it says, only a few has read image data [ many (a part for said overlap) ] in the fingerprint image of one frame from one sixth of all image fields.

[0080] Since said DSP takes about 0.24 seconds to evaluate said necessary minimum singular point crest information in fingerprint authentication even if it is going to cover all image fields from the fingerprint image of one frame, it becomes impossible to cover in 1 / 25 seconds, or 30 seconds (Japan-U.S. NTSC system television) in 1/seconds that scans one frame. then, a machine carries out fingerprint authentication, catching 1 set of fingerprint image information intermittently for said every small block image, and processing it each time ranging over 6 thru/or the time amount for seven frames, i.e., 25 6/seconds, and 30 7/seconds, -- a convenient abbreviation -- it carries out to unique numerical information, i.e., the fingerprint description data, and puts in a database.

[0081] Here, on the occasion of the actual employment approach of a fingerprint authentication system, much fingerprint description data which serve as a candidate for collating first of all are registered into a host computer or the

database of an information centre. Next, the fingerprint description data are extracted from the fingerprint image picturized for the check, and it uses for fingerprint authentication. the collating degree criterion which was registered into said database, collated with much fingerprint description data used as the candidate for collating, and was defined beforehand -- "truth" and a "false" -- judging .

[0082] For example, as a scale of the rightness of fingerprint authentication, as a probability collated correctly, although it is an ideal that it is the rate of the "true" fingerprint which there is "a rate of collating" and is contained in the sample judged to be "truth", and is 100% It is also being unable to judge, if scrupulous [ in this / to 100% ] and it is not the perfect fingerprint authentication containing no noise component, and a registration fingerprint cannot be received by the remarkable high probability.

[0083] Although it is an ideal that it is the rate of the "true" fingerprint which does not come out further so much, and there is "a rate of un-collating" which judges a "false" accidentally, and is contained in the sample judged to be a "false" in spite of being a "true" fingerprint, and is 0%, if the above "the rate of collating" is set up to 100%, it will become about several% of above "the rate of un-collating."

These concepts are the same as that of "truth" of the tag in an automatic vending machine etc., and a setup of "truth judging collating sensibility" looked at by the

"fake" judgment collating system itself, and level setting on which it can compromise constitutes them practically.

[0084] Even if it set up the above "the rate of collating" to 100% according to this invention, it succeeded in small or suppressing the above "the rate of un-collating" to 1.2%. If this is compared with \*\* "the rate of un-collating" of the highest conventional fingerprint authentication system in the world having been 27.72%, it can be said to be an epoch-making success. Especially this also means that discernment capacity became high to an input fingerprint image with rotation, migration, and a noise.

[0085] Moreover, the computer which has the digital signal processor in which per second 100 million instruction execution is possible operates collection of said fingerprint description data, and a series of data processing of collating, and if it identifies with said collating means which assigned said fingerprint description data around 50 bytes per fingerprint image, a series of actuation of the noise rejection of an input image, an image improvement, binary-izing, fragmentation, and collating can be processed in 0.24 seconds. this can be said to be that it was markedly alike and a high speed and positive collating were completed rather than the conventional thing as practical use level.

[0086] moreover -- if an information communication link is carried out with the information centre which connected to the communication network and a

database possesses -- a remote place -- him -- it can check.

[0087] moreover, the logical operation which becomes in combination, such as AND, NAND, OR, and NOR, about the fingerprint description data of two or more fingers in the fingerprint description data of two or more fingers -- him -- the regulation of a check was set up. Thus, setting \*\*\*\* which carries out licence of the fingerprint data of each father, mother, and child all the members' thumbs by OR can be used for the automobile operation locking equipment which is good for locking common to a family exactly, and can set up family limitation etc. and two or more men suitably free as a rightful claimant's tolerance by making locking of a house into the start, for example, suits special agreement matters, such as family limitation in an automobile accident liability insurance. By that of 20 \*\*\*\*\*, the combination which becomes by the series count is rich in variety from a recitation number, and, moreover, the protective effect for protection is strengthened with one person greatest. For example, it will be made the conditions of authorization if AND of the right thumb and a left index finger is suited. And a confidentiality obligator etc. should leak fingerprint data with intentionally or negligence, or when it embezzles, expansion of damage can be prevented, if said combination is promptly changed into AND of a digitus minimus on either side etc. when he has perceived that.

[0088] in addition -- even if it becomes the environment "it has the legal

effectiveness that a recitation number is equivalent to a signature" under the revised law in U.S. electronic commerce -- him -- as commonsense and ultimate decision, the thing which are related with an acknowledgement function and for which a high order positions the fingerprint rather than a recitation number is inevitable.

[0089]

[Effect of the Invention] Since the curvilinear discernment system was constituted as explained above, according to invention concerning claim 1, a curve can be expressed with small memory space. Therefore, if it is the curve which the direction of a curve does not reverse, the length of a curve and a configuration can be correctly memorized, reproduced or collated only by the numerical group of measurement data. And even if it moves or rotates a sample, curved discernment can be performed convenient. That is, the data format showing this curve is how to express a curvilinear configuration strong against migration or rotation. Generally, if it is the comparison of only a numerical group, the machine is more advantageous than people positively. Even if people can do these things, they transpose at a machine "the configuration pattern recognition of a thing" made comparatively difficult for a machine to abbreviation completeness, and in addition, they bring about a high speed and the effectiveness which can be processed correctly for a vast quantity of databases

of more than forge fire.

[0090] Moreover, since a count top can also presume strictly the point overlooked by existing in clearance parts of two or more pixels which have the visual performance arranged full of clearances when expanding and seeing, such as an image pick-up side which cannot exist only with the resolution of finite, according to invention concerning claim 2, the resolution of infinity can be pursued theoretically.

[0091] Moreover, even if it is the curve which the direction of a curve reverses to the shape of S character according to invention concerning claim 3 A configuration is identified specifying to the curve direction of the curve, the reappearance to a curve from a numeric value also becomes completely possible, and if numeric values other than the numeric value which shows a direction are in agreement also in the curve which rotated on the recognition screen further, though it is the curve of the similar configuration, it becomes possible to identify those differences. Paradoxically, if the curve of a similar configuration is collated at a glance, it can conclude that that it is the same curvilinear configuration probably only rotated.

[0092] Moreover, according to invention concerning claim 4, it becomes possible to identify that by the difference in the numeric value which shows the location which the curve moved on the recognition screen. Paradoxically, if the curve of a

similar configuration is collated at a glance, it can conclude that that it is the same curvilinear configuration probably only moved.

[0093] Moreover, according to invention concerning claim 5, fingerprint authentication is possible at the high rate of collating also to the input image of the fingerprint containing a noise.

[0094] Moreover, according to invention concerning claim 6, the fingerprint which was not able to be registered only in a singular point crest configuration is also registered about 100%, and can be collated now.

[0095] Moreover, according to invention concerning claim 7, it becomes the best for machine collating of the huge number of samples, and a high speed and exact fingerprint authentication become possible with the simple facility which makes the start the amount of memory smaller than before.

[0096] Moreover, according to invention concerning claim 8, it became possible to distinguish the false focus generated by the noise from the singular point true in small computational complexity and a high precision.

[0097] Moreover, a system configuration can be carried out in small memory space, without accumulating the raw image data of the whole fingerprint image which was wasting memory space, i.e., the image information before making amount-of-information reduction processing, according to invention concerning claim 9.

[0098] Moreover, according to invention concerning claim 10, since retrieval called parallel displacement actuation and a comparison in gap amendment of the parallel displacement of a fingerprint was not performed, very high-speed fingerprint authentication became realizable.

[0099] Moreover, according to invention concerning claim 11, since retrieval called rotation actuation and a comparison in gap amendment of a rotation of a fingerprint was not performed, very high-speed fingerprint authentication became realizable.

[0100] Moreover, according to invention concerning claim 12, the simplification of a facility is realizable, maintaining practicality.

[0101] moreover, according to invention concerning claim 13, a collating rate and the rate of collating can be raised by small memory space, as practical use level, it is markedly alike and a high speed and exact collating can be performed rather than the conventional thing.

[0102] Moreover, according to invention concerning claim 14, reduction of still larger memory areas and collating at a high speed can be performed.

[0103] Moreover, according to invention concerning claim 15, use of the fingerprint authentication in a remote place can also be performed.

[0104] moreover, him who had distinguished conventionally in a card, a key, a ticket, a commuter pass, a signature, seal, the BADGE, a face, and his voice

according to invention concerning claim 16 -- it is made to require only momentary fingerprint authentication about a check

[0105] Moreover, according to invention concerning claim 17, it becomes the cost reduction of security management to the object article of security.

[0106] Moreover, according to invention concerning claim 18, two or more men can be suitably set up free as a rightful claimant's tolerance with family limitation etc. For example, it can use for the automobile operation locking equipment which suits special agreement matters, such as family limitation in an automobile accident liability insurance. By that of 20 \*\*\*\*\*\*, the combination which becomes by the series count is rich in variety from a recitation number, and, moreover, the protective effect for protection is strengthened with one person greatest.

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#### DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the explanatory view of evaluation of the description bowstring.

[Drawing 2] It is drawing which the curve which should be identified moved and rotated.

[Drawing 3] The explanatory view of the principle which carries out the approximation calculation of the coordinate value of the point of measurement which exists in the clearance part of a pixel.

[Drawing 4] It is the explanatory view of the curvilinear configuration system using the azimuth and curvature of the focus.

[Drawing 5] It is a true singular point extract algorithm by thinning and POJINEGA reversal.

[Drawing 6] It is the true singular point extract algorithm included to the gray-scale image improvement means.

[Drawing 7] It is the explanatory view of the false singular point,

(a) It is the explanatory view of the endpoint which approaches with the crest of the same direction.

(b) It is the explanatory view of the endpoint close to the branch point.

(c) It is the explanatory view of the endpoint close to the frame of an image.

[Drawing 8] It is the explanatory view of the singular point extraction method by tone reversal and thinning,

(a) It is the explanatory view of monochrome block image before processing.

(b) It is the explanatory view of the extract singular point of halfway processing.

(c) It is the explanatory view of a tone reversal block image.

(d) It is the explanatory view of the extract singular point after a final treatment.

[Drawing 9] It is the explanatory view of the curvilinear discernment system using

the secondary focus.

[Drawing 10] It is the explanatory view of the judgment using an inner product of removal of the false singular point.

[Drawing 11] It is the explanatory view of the storing memory area of the accumulation value of the similarity index value in the collating approach which does not need the gap amendment about a parallel displacement.

[Drawing 12] It is the singular point extract algorithm of a raster scan and the recognition processing by evaluation of a full screen.

[Drawing 13] It is the algorithm of a fingerprint authentication system.

[Description of Notations]

10 1st Pixel Location

11 2nd Pixel Location

12 Point of Measurement

20, 21, 22 Endpoint

30 Singular Point

40,400 A curve or crest

41, 42, 43, 44 Bowstring of unit length

12, 31, 32, 33, 34 Point of measurement

51, 52, 53 The description bowstring

91 Focus

92-95 Secondary focus

99 Regular Slant Range

100 Reference Point

101,401 Branch point

102,103,104 Point on a crest or a valley line

402-405 Locus point

407 Reference Axis

408 Azimuth of Focus

409,410,411 Whenever [ curvature ]

501-504 Bowstring of die-length D

RS1-RS4 Configuration of the crest which makes the secondary focus the starting point